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## **Promise or Threat?**

The Co-production of Technology and Politics in Uranium Enrichment in Iran

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When I started my studies at the age of 19, I was overwhelmed with the countless study options at the University of Oslo. I studied history, politics, and literature, Persian, English, and Middle Eastern Studies. However when the time came to apply to a master's degree it seemed I had to choose one of the above disciplines. By chance I heard about the Science, Society and Technology MA-course at the TIK Centre at the University of Oslo, who favored my interdisciplinary background. I am grateful for the TIK Centre's work of uniting different academic disciplines in an interdisciplinary framework, and for giving me the opportunity to study in such a vibrant and stimulating environment. I owe a special thanks to Professor Göran Sundqvist, my supervisor at the TIK Center, who guided me along the way with all his knowledge and encouragement. I would not have been able to do this without you.

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## **Abstract**

The thesis' point of departure is to recapture the co-production idiom within the field of Science and Technology Studies (STS) when analyzing Iran's nuclear energy development, especially their uranium enrichment technology, and its political dependency. First, the thesis presents an overview of Iran's nuclear development, and further explains why the uranium enrichment technology in Iran has become a controversial topic in the international community. Further the thesis explains how nuclear technology in the West has regained a newfound optimism the last ten years, and how the West attempts at the same time to delegitimize and exclude this development in Iran. Thereafter the thesis describes why there was a need for a political structure for nuclear technology development, which was realized through the nuclear non-proliferation regime that have the aim of preventing nuclear weapon proliferation. The thesis describes both the Iranian view and the Western view on nuclear energy technology development. How has politics contributed to the idea that nuclear energy technology development is either "good" or "bad" depending on the country that develops it? The aim is to examine and describe both technological and political causes and effects of nuclear energy technology development.

**Keywords:** *nuclear energy, Iran, nuclear enrichment, nuclear fuel cycle technology, technology and politics, Science and Technology Studies, co-production*



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## Abbreviations

AP	Additional Protocol to Safeguards Agreements
CO <sub>2</sub>	Carbon Dioxide
EU	European Union
EU-3	Britain, France and Germany
FEP	Fuel Enrichment Plant (in Natanz)
FFEP	Fordow Fuel Enrichment Plant
HEU	Highly Enriched Uranium
HWPP	Heavy-Water Production Plant
IAEA	International Atomic Energy Agency
ISIS	Institute for Science and International Security
LEU	Low-Enriched Uranium
LEUF <sub>6</sub>	Low-Enriched Uranium Hexafluoride
LEUO <sub>2</sub>	Low-Enriched Uranium Oxide
LWR	Light Water Reactor
NEA	Nuclear Energy Agency
NFCT	Nuclear Fuel Cycle Technology
NNWS	Non-Nuclear Weapon State
NPT	Nuclear Non-Proliferation Treaty
NSG	Nuclear Suppliers Group
NTI	Nuclear Threat Initiative
NWS	Nuclear Weapon States
OECD	Organization for Economic Co-operation and Development
PFEP	Pilot Fuel Enrichment Plant (in Natanz)
P5+1	The five permanent members of the United Nations Security Council + Germany
STS	Science and Technology Studies
TRR	Tehran Nuclear Research Reactor
UF <sub>6</sub>	Uranium Hexafluoride
UNSC	United Nations Security Council
US	United States
WGU	Weapons Grade Uranium

## *Ghazal 323*

Laden with my ignorant ties  
Ashamed of the courageous and wise  
May a hidden hand help me rise  
Or else madness becomes my prize.  
Of stars and fate ask of my eyes  
That watch the havens until sunrise.  
I kiss the cup that me apprise  
Of the world's turnings and its disguise.  
Praise of wine-sellers' reprise  
Praise of God's bounty, why despise.  
Grateful for my power and size  
Unable to deal in deceit and lies.  
Drunk like Hafiz, till my demise,  
Hopeful of that angel's enterprise.

*Hafez*

1325-1390

Originally in Persian

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# **Part One**

## **1 Introduction: Nuclear Iran**

The development of nuclear technology in Iran dates all the way back to 1957 with the United States (US) and Iran signing the civil nuclear cooperation agreement as part of the US Atoms for Peace program (ISIS 2010a). The development of nuclear technology in Iran is more significant than just to achieve greater energy production in an effort to solve the increasing energy consumption of their rapidly growing population. For Iran, the nuclear program is a key to higher status, enhanced security and a stronger role in the Middle East, as well as to level out the asymmetries the West has enforced on them through not including Iran as a significant actor on the international scene (Lodgaard 2010). Iran's nuclear technology is both about technology and politics, and the ambition is to strengthen Iran's national independence and self-sufficiency through attaining competence in nuclear technology. Nuclear technology has raised Iran's international standing, and resembles the role nuclear weapons played in the revival of France as a big power with an independent foreign policy in the 1960s, yet without necessarily turning Iran into a Nuclear Weapon State (NWS) (Lodgaard 2010).

The nuclear technology development in Iran has been a catalyst in controversies concerning international security politics and non-proliferation of nuclear weapons. The United Nation Security Council (UNSC) and the International Atomic Energy Agency's (IAEA) ultimate goal concerning nuclear technology development in Iran is to achieve transparency regarding their nuclear technology development. The

UNSC's attempt to control Iran's nuclear future is transparent, especially the sensitive Nuclear Fuel Cycle Technology (NFCT) development concerning uranium enrichment technology. The West, the UNSC and the IAEA view uranium enrichment as the critical part of the nuclear development in Iran, because it is a sensitive technology with a dual function that may be used to produce nuclear weapons. Iran's actions in the nuclear field has in recent years added to the already existing lack of trust towards Iran, and has led the West to deal with Iran's nuclear development with an even higher degree of distrust and skepticism. Both the UNSC and the IAEA has demanded Iran to halt their uranium enrichment activities, until they have achieved transparency in their nuclear activities, additionally they want answers to outstanding questions concerning possible nuclear weaponization activities (Security Council 2006). The Iranian government express that they undergo unjust and discriminatory treatment by these actors, and they have not implemented the measures the UNSC and the IAEA have requested, causing lack of progress in the negotiations from all parties in the matter.

The aim of this thesis is to analyze the role NFCT development has in politics. The objective is to analyze how nuclear development is dependent on political development and vice versa. Further, the thesis tries to shed light on ways in which NFCT and politics are linked. The overlying research question can thereby be formulated:

*In what ways is the development of uranium enrichment technology in Iran a necessity for their nuclear energy technology development as well as a political tool?*

In answering this question, the thesis takes as its point of departure the idea of co-production of technology and politics, which explains how interaction between technology and politics shape each other through interdependent processes of evolution. The key findings of co-production are central to understanding the role of NFCT in political development. The usefulness and explanatory power of this perspective is illustrated by a case study of one of the most challenging nuclear fuel cycle developments that exists today, the uranium enrichment technology development in Iran.

The thesis analyzes how certain parts of the development of NFCT may present disadvantages and problems within realizing non-proliferation of nuclear weapons. The Nuclear Non-Proliferation Treaty (NPT) is a treaty on non-proliferation of nuclear weapons (IAEA 1970). The IAEA safeguards the Non-Nuclear Weapon States (NNWS), in the effort to verify the non-diversion of declared nuclear materials. All NPT-members equally have the right to develop nuclear energy when they act in accordance to the treaty (IAEA 1970). The NPT aims to avoid discrimination of its member-states, and all NNWS that have nuclear development on any scale have to be safeguarded by the IAEA (IAEA 1970).

There have been many incidents in the past (going back many decades) that have strained the relationship between Iran and the West. The thesis examines the nuclear development in Iran in an attempt to understand both the Iranian and Western viewpoints on the Iranian nuclear development. The thesis will present how the different parties in the global nuclear energy discourse deal with Iran's nuclear development. The UNSC and the IAEA want reassurance that Iran's nuclear

development is for solely peaceful purposes. They express that their intention is to achieve a greater cooperation with Iran in the pursuit to achieve greater transparency within Iran's nuclear program. However, Iran does not trust that these actors will keep their promises in a nuclear cooperation, and this contributes to Iran wanting to achieve a state of self-sufficiency in the nuclear field and does not want to become dependent on others, especially Western actors. There are many ways in which the West may be defined, the traditional definition of the Western World is that it consists of the US and Western Europe. However, in this thesis the definition is much wider, and the West represents the traditional definition of the West as well as their allies, which includes countries that are allies of the US and Western Europe, such as Canada, Israel, Australia, Japan, South Korea, and in some situations also include Russia and China. This wide definition of the West may be used as an entity that represents a collective front against nuclear development in Iran.

### **1.1 Theory: The Co-production of Technology and Politics**

Langdon Winner is a well-known scholar in Science and Technology Studies (STS), who has contributed with the idea of a codependent as well as intertwined relationship between technology and politics. In "Do Artifacts Have Politics?", from 1980, Winner explains that technology is a man-made technological infrastructure that causes particular kinds of political relationships (Winner 1980:123). This article has contributed immensely to the STS field, and has been the catalyst of many debates concerning whether or not technology and politics are dependent of one another. Winner is viewed as one of the first scholars that presented this notion, a notion that has become a highly recognized understanding of the relationship between technology and politics in STS.

In the article Winner presents the idea that some technologies have an inherent political quality, and uses the atomic bomb as an example. The idea is that some artifacts may have political qualities even when isolated from society. The notion of inherent political qualities in artifacts has been criticized and disputed by other STS scholars. Steve Woolgar and Bernward Joerges are some of the scholars that have challenged Winner's idea of inherent political artifacts. Winner is criticized especially in Woolgar's article, "The Turn to Technology in Social Studies of Science" (Woolgar 1991). In Joerges article, "Do Politics Have Artefacts?" both Winner and Woolgar are discussed, and referred to as scholars on opposite ends of the theory scale (Joerges 1999). Joerges agrees with Woolgar that Winner's notion that artifacts have inbuilt political qualities is not an accurate description of reality. They especially criticize this notion because Winner states that these artifacts are political even when isolated from the society. In short, Joerges and Woolgar state that Winner has misinterpreted reality, and in fact it is the society that chooses whether to use artifacts as political tools or not, therefore it does not make any sense to analyze artifacts without the society in the equation. Even though other scholars have heavily criticized Winner, his contribution to the STS field is important, because he introduced the understanding of codependent and intertwined relationships between technology and politics.

Winner explains that adoption of a technological system actually requires the creation and maintenance of a particular set of social conditions as the operating environment of that system (Winner 1980:130). NFCT is a technology that may be analyzed through understanding and using Winner's concepts as an analytical framework because it needs an effective operating entity where social as well as material

conditions are met. The development of NFCT requires the development of particular political means because of the sensitive nature of NFCT, the actual regulation and verification of the technological system is of significant importance, and requires its social environment to be structured in a particular way.

Winner also emphasizes on the significance of the intertwined relationship between technology and society, he illustrates this clearly through the implementation of the mechanical tomato harvester in California in the late 1940s:

Once the mechanical tomato harvester had been developed in its basic form, design alteration of critical social significance – the addition of electronic sorters, for example – changed the character of the machine's effects on the balance of wealth and power in California agriculture. Some of the most interesting research on technology and politics at present focuses on the attempt to demonstrate in a detailed, concrete fashion how seemingly innocuous design features in mass transit systems, water projects, industrial machinery, and other technologies actually mask social choices of profound significance (Winner 1980:127).

Winner highlights how the implementation of a technical device has multiple social consequences. When introducing new technologies in society new challenges appear, and the given society may require a new framework to regain public order. To some degree our society relies on technical devices to maintain our way of living, these devices have become integrated parts of our everyday life. Implementation of a technology may also, as Winner points out, cause a new balance of power, and controversies may appear.

The tradition of uniting technological and political development in a social framework has become a far more accepted and broadened perception of how change occurs in the society. Co-production is a theory that has the desire to avoid both social and



techno-scientific determinism in STS accounts of the world (Jasanoff 2004:20), and at the same time explain both technological and political change as part of a codependent relationship. As long as Winner's inherent political artifact notion is excluded it is possible to unite Winner's notions and the co-production concepts as one theory, and go forth with co-production as the analytical tool in understanding the dynamics of the links between nuclear technology and politics in Iran.

Sheila Jasanoff is also a well-known scholar in STS, because she introduced the co-production concept and outlined and elaborated on how the actual relationship between science (and technology) and politics are interrelated. She explains that science and technology are interwoven with issues of meaning, values, and power (Jasanoff 2004:15). Challenges in the most enduring topics in politics and technological development, like nuclear energy development and at the same time insurance of non-proliferation of nuclear weapons, are well illuminated in a co-productionist mode, because it explains how technology and politics affect each other. Understanding this process, which is a continuous never-ending relationship, helps us grasp the significance of technological development. Jasanoff explains that with technological development the national and global constitutional orders are constantly remade in innumerable, localized engagements (Jasanoff 2004:43). The idiom of co-production "offers a new way of exploring the waters of human history, where politics, knowledge and invention are continually in flux" (Jasanoff 2004:43). Jasanoff's co-production idiom is basically an attempt to unify the notions of science and society, and further understand how they interact. This notion does not claim to fully exclude other concepts, but to lay ground for a description of cases and effects of science and politics have on one another.

In Rolf Lidskog and Göran Sundqvist's article "The Role of Science in Environmental Regimes: The Case of LRTAP" co-production of science and policy is explained as the shaping relationship between scientific knowledge and political order through an interdependent process of evolution (Lidskog and Sundqvist 2002:84). They further explain that co-production means a dialectic explanation of technology and policy, which claims that policy influences the production and stabilization of knowledge, while the knowledge simultaneously, supports and justifies policy (Lidskog and Sundqvist 2002:84). The idea is that the production of (technological) knowledge is also production of policy, so that causes and effects become functionally interrelated (Lidskog and Sundqvist 2002:85).

The understanding of co-production may be highlighted through the notion that people accept some specific knowledge-claim because it supports their policy strategies. Lidskog and Sundqvist (2002:85) state, "co-production means that uncertain or contested science can grow stronger if the policy context is "right", while on the other hand, a weak policy context can become stronger through the support of science". Co-production is explained as science and policy being part of the same culture, and common and supported social projects strengthens and legitimizes both technology and policy (Lidskog and Sundqvist 2002:85). Lidskog and Sundqvist conclude that technological development has to be supported by social conditions to become relevant for policy-making.

Jasanoff (2004:39-41) has proposed four mechanisms by which science (and technology) may become policy-relevant, meaning scientific (and technological) knowledge becoming influential, which Lidskog and Sundqvist (2002:86) have

elaborated further:

Scientific (*technological*) knowledge can be influential:

1. if it supports politically accepted forms of discourse and reasoning,
2. if communities that have a privileged right to formulate policy ratify it;
3. if convergent economic interests of business and government support it, allowing science (*technology*) to play the role of a visible consensus builder;
4. if it is part of a general technological culture, where technocratic solutions of political problems are supported.

These four mechanisms illustrate that technological knowledge needs to be adapted to the social and political order to be influential and in order to acquire the social authority for being policy-relevant (Lidskog and Sundqvist 2002:86). The basis of a supportive political order towards the technology has to be in place for the process of establishing the technology to take place. Basically to achieve implementation of the technology there has to be political support. At the same time technological knowledge play an important role in the political sphere. Therefore technology and politics may be explained as the same underlying social order (Lidskog and Sundqvist 2002:86).

On the surface of nuclear technology development in Iran it is obvious that technological development and political development are linked. Through using the theory of co-production the thesis is going to attempt to demonstrate how nuclear technology development in Iran and political development are linked and co-produced as well as entwined and interconnected. Jasanoff's four mechanisms stated above will be used more extensively, when analyzing Iran's nuclear development, later on in the thesis. The aim is to explain how these four mechanisms occur in Iran's and the West's nuclear development as the means of illuminating co-production of

technology and politics in the nuclear field.

### *1.1.1 Technology and Politics as Interdependent and Intertwined*

To understand the notion of co-production of technology and politics, it is important at this stage that some words and concepts are clarified. Above it is stated that both Winner and Jasanoff stress that technological development is dependent on and intertwined with political development and vice versa. Technology and politics as dependent factors means, if one changes the other has to change as well in order for the development to be successful. The intertwined relationship is even more complicated to grasp. Intertwined features may be technological achievements that directly cause political challenges, as well as the other way around. Jasanoff explains the co-production of science (technology) and politics through identities, institutions, discourses, and representations (Jasanoff 2004:38). “Doing science merges, in other words, into doing politics” (Jasanoff 2004:29). The boundary between what is technology and what is politics are not easily distinguished, which explains the intertwined relationship of technology and politics.

## **1.2 Method: Case Study and Text Analysis**

The thesis’ main objective is to answer the research question presented above.

Through analyzing the development of Iran’s uranium enrichment technology by the co-production of technology and politics framework, the aim is to describe in what ways both technology and politics are codependent and intertwined in Iran’s and the West’s nuclear field. This chapter will elaborate the methods that have been used in the pursuit to answer the research question.

The research method is based on the case study of Iran's uranium enrichment development explained through the co-production idiom. Iran's uranium enrichment has been a topic that has received a great deal of attention because the West and Iran do not agree on which path the future of nuclear technology should take in Iran. The thesis emphasizes mainly on these two actors. Through text analysis the thesis aims to explain the codependent and intertwined relationship of technology and politics within nuclear technology development, with emphasis on Iran's uranium enrichment.

The process of collecting data about Iran's uranium enrichment development was in some instances challenging due to little available data. The IAEA has inspected some of Iran's nuclear facilities, and distributed the technical information concerning Iran's nuclear development in reports that are found on their website. Additionally, IAEA distributes their correspondence with Iran, and Iran's correspondence with IAEA on their website. The thesis will use this correspondence extensively, as an effort to balance both the Western and Iranian perspective on nuclear development in Iran, and for technical information it will use IAEA reports.

There are many organizations, especially in the US, that focus on eliminating nuclear weapons proliferation, such as the Nuclear Threat Initiative (NTI), and Institute for Science and International Security (ISIS). The NTI's objective is to develop and implement new ways of dealing with nuclear, biological and chemical threats (NTI 2010c). ISIS aims to expose nuclear weapon proliferation activity through technical assessments, and has been at the forefront internationally to unveil clandestine nuclear activity (ISIS 2010b). These two organizations do extensive research on Iran's nuclear development and distribute information on their websites. Although these

sources are somewhat biased and may present the West's negative view against the Iranian regime, they are still good sources that may be used to achieve a historical overview of Iran's nuclear development.

The literature presented is a good foundation for the further writing process of the case in the thesis. The trend is, however, that the sources in the thesis are mostly Western, which makes it even more important that the sources are used critically because of their point of departure.

### *1.2.1 The Structure of the Thesis*

The thesis is organized in three main parts. Part one is the elaboration of the thesis' theoretical framework, which consists of chapter 1. In this chapter Jasanoff's co-production of technology and politics was presented. Part two describes the understanding of the controversies within nuclear technology and politics in the international community, with especial emphasis on Iran's uranium enrichment development. This is elaborated in chapters 2-5. Part three attempts to unite uranium enrichment technology development in Iran with the theory of co-production of technology and politics in the effort to understand the significance of the intertwined relationship between the two from the perspectives of both Iran and the West. This analysis is presented in chapters 6 and 7.

Part two of the thesis gives grounds for the description of the case and explains the relationship between technology and politics in the nuclear field. These chapters require some more explanation. Chapter 2 is a historical overview of Iran's nuclear development, and a description of uranium enrichment technology and how it has

become a controversial development in Iran. Furthermore the chapter explains how nuclear technology in the West has regained a newfound optimism during the last ten years, although not valid in Iran from the Western perspective. Chapter 3 presents the nuclear non-proliferation regime, and gives an historical overview of the establishment of IAEA, NPT and the Nuclear Suppliers Group (NSG). The chapter describes how these organizations are political instruments, which aim to prevent nuclear weapon proliferation. Chapter 4 describes how uranium enrichment may be explained as a political tool as well as a technological necessity for nuclear technology's future in Iran. Chapter 5 gives an overview of what the West perceives as the solution to coping with the expansion of nuclear technology, which is multilateral cooperation in the nuclear field.

## **Part Two**

### **2 Background: Nuclear Iran**

The Western World has been scrutinizing Iran's nuclear development especially after the Iranian revolution in 1979, when the Pahlavi monarchy was thrown and replaced by an Islamic republic. In August 2002, the Iranian opposition group called National Council of Resistance of Iran revealed information about two secret nuclear sites under construction in Iran (ISIS 2010a). The two revealed nuclear sites turned out to be a Heavy-Water Production Plant (HWPP) in Arak, along with a uranium enrichment plant in Natanz consisting of a Fuel Enrichment Plant (FEP) and a Pilot Fuel Enrichment Plant (PFEP) (Kippe 2009:15). Both facilities are considered highly relevant for a potential nuclear weapons program, but could also have legitimate peaceful purposes. The revelation of these two clandestine nuclear facilities accelerated the comprehensive struggle between Iran and the international community. The Western powers have been on the forefront of accusing Iran for developing nuclear weapons, while Iran constantly has claimed that their nuclear activities are completely peaceful.

Iran is a state-party to the NPT, which obligates Iran to declare all its nuclear activities to the IAEA, who in return ensures Iran an inalienable right to develop nuclear energy technology. Caught in the middle of the struggle, stands the IAEA as a mediator, striving to prevent the proliferation of nuclear weapons while securing all member states inalienable right to peaceful nuclear technology. Iran has not breached the first safeguards agreement with the IAEA regarding the facilities in Natanz and



Arak, which states that countries that have signed NPT are obligated to declare their nuclear facilities within 180 days prior to nuclear materials being introduced (Kippe 2009:15). In short, it has not been proven at this time that Iran has breached its NPT commitments, although Iran has been found in noncompliance with its newer safeguards agreements. Covert fuel cycle facilities are largely viewed as evidence of a clandestine nuclear weapons program, although fuel cycle facilities are legitimate under the NPT.

## **2.1 Nuclear Development in Iran**

As mentioned in chapter 1, Iran's ambitions within the nuclear field dates back to the 1950's. Iran's nuclear development started in an alliance with the US through the US Atoms for Peace program (ISIS 2010a). The agreement was that the US was going to provide Iran with technical assistance and lease of several kilograms of enriched uranium and cooperate on research on the peaceful uses of nuclear energy. The US supplied the Tehran Nuclear Research Center with a small research reactor (TRR), in 1967 (NTI 2010b). The Iranian government signed the NPT in 1968, on the day it opened for signature (NTI 2010b). During a trip to Iran in 1974, US Atomic Energy Commission chairperson Dr. Dixy Lee Ray suggested that Iran should establish enrichment and reprocessing facilities (NTI 2010b). Since Iran had developed an impressive baseline capability in nuclear technologies by the mid 1970s, the US viewed Iran as the potential country in the Middle East that could establish enrichment and reprocessing facilities to supply the whole region, which are the two most sensitive parts of nuclear fuel cycle technology (NTI 2010b). However, after the revolution in Iran in 1979, the US has been the most critical actor towards Iran's nuclear development.

The 1979 Iranian Revolution stalled Iran's nuclear program, as Ayatollah Ruhollah Khomeini largely abandoned the Shah's agenda, canceling almost all of the Islamic Republic's nuclear contracts with foreign companies (NTI 2010a). Work on the Bushehr nuclear reactors was suspended, but nuclear research at the TRR continued (NTI 2010a). However, in 1984 Khomeini expressed a renewed Iranian interest in nuclear power, seeking the assistance of international partners to complete construction at Bushehr (NTI 2010a).

In the aftermath of the Iranian Revolution in 1979, there was a clear shift in the West's will to cooperate with Iran in the nuclear field. The United States, France and Germany failed to fulfill their promises to provide assistance to the Iranian nuclear program. The development of Iran's nuclear program met more barriers in gaining an understanding of nuclear technology during the eight-year long war with Iraq in the 1980s. During the war, the research reactor in Bushehr was bombed, while most Iranian research scientists and nuclear experts emigrated from Iran (Melman and Javedanfar 2007:99-100). This loss, compounded by Ayatollah Ruhollah Khomeini's previous opposition to nuclear technology, resulted in the near disintegration of Iran's nuclear program post-1979 (NTI 2010a).

However, Iran began investing more heavily in nuclear technology again following the Iran-Iraq War. Iran had to rebuild parts of their nuclear program from scratch, and the development progressed slowly because Iran received very limited if any assistance from the West. One clear example is when Iran requested assistance from IAEA to build a uranium conversion facility in the early 80s, the US directly hindered this cooperation to take place (Kippe 2009). The Iranian government had to seek for

nuclear assistance from other actors in the nuclear field. During the 1980s and 1990s the Iranian government received nuclear know-how and assistance from China, Russia and Pakistan. While China provided Iran with a research reactor in Esfahan, the Russian government committed itself to complete the unfinished project in Bushehr (Melman and Javedanfar 2007:100-103). At the same time, Iranian students received education on nuclear technology in Pakistan.

## **2.2 The Nuclear Dispute between the West and Iran**

Iran's nuclear program is long rooted in the history, but the current nuclear dispute between the West and Iran did not arise until August 2002. The disclosure of the undeclared nuclear facilities in Natanz and Arak, which was built in secrecy by the Iranian government, created apprehension about the risk of nuclear weapons proliferation (Kippe 2009:7). In the aftermath of the August 2002 discovery, a new undeclared facility was revealed at Lavizan-Shian in 2003, but the facility was demolished a few months after the discovery (Kippe 2009:54). The facility was alleged to be the center for Iran's nuclear weapons design effort. There were also reported some suspicions concerning nuclear activities in Parchin, but after IAEA gained access to the site the accusation was withdrawn. However, in September 2009, the existence of a second, smaller uranium enrichment plant under construction in Fordow, near Qom to the south of Tehran, was revealed (IAEA 2009). Iran had again failed to inform IAEA about its intention to build a nuclear facility.

The dispute is mostly surrounded Iran's uranium enrichment activity, and the West demands Iran to halt their uranium enrichment, in fear of nuclear weapon proliferation. Additionally, the West demands Iran to clarify past activities that may

have been for nuclear weapons purposes. Essentially, the main issue causing the dispute is that the West wants to eliminate Iran's technical ability to create nuclear weapons, most importantly Iran's uranium enrichment facilities.

### *2.2.1 Uranium Enrichment*

There are a few different ways to make nuclear reactor fuel of natural uranium; Low-Enriched Uranium (LEU) fuel is the most common fuel in nuclear power reactors. Uranium enrichment is one of the many processes natural uranium has to go through to become LEU fuel used in nuclear energy production (NEA 2008:60). Enriched uranium provides the fuel for most of the world's nuclear power reactors, and the enrichment process is a vital process in a multi-step nuclear fuel cycle (IAEA 2009). The technology is viewed as sensitive and strategic, because the enriched uranium may be used both to produce nuclear weapons as well as nuclear power generation, depending on its enrichment level (Cassedy 1998:173).

Nuclear power utilizes nuclear fission, in which fissile nuclei (such as uranium-235) split into lighter elements, releasing kinetic and radiation energy in the process. The significance of nuclear fission lies in the ability to form a chain reaction, where the neutrons liberated by the fission of one nucleus move on to create other fission reactions (Cassedy 1998:173).

The successive collisions and fission reactions can create a self-sustaining chain reaction, with the condition that there is a large enough amount of the fissile material, a so-called critical mass. The critical mass is the fuel needed to sustain the chain reaction. In other terms, the critical mass is when the density and total mass of the

fissionable fuel is great enough to sustain the chain reaction (Cassedy 1998:173). This chain reaction is the phenomena behind both the nuclear bomb and the nuclear energy reactor, with the most important distinguishing characteristic being that in a reactor the rate of fission reactions can be controlled (Cassedy 1998:173).

The most common fissionable element is uranium, which has several isotopes. The main isotope uranium-238 cannot sustain a nuclear chain reaction on its own. The only nuclide found in nature that can support a nuclear chain reaction is uranium-235, however in natural uranium, for every 140 atoms of uranium-238 there is only one atom of uranium-235 (Medvedev 1990:4).

Plutonium is the most important fissile material apart from uranium. More specifically plutonium-239 is a manmade fissile isotope, which is produced by conversion of uranium-238 through neutron absorption and subsequent beta decays. Basically, when neutrons collide with the nuclei of uranium-238 some of the uranium-238 nuclei transform into plutonium-239 (Medvedev 1990:5).

Natural uranium may be used to fuel nuclear reactors, as long as the reactors are moderated by (i.e. the neutrons are slowed by) heavy water or graphite (Kippe 2009). However, natural uranium cannot be used to fuel a nuclear bomb, because it cannot sustain a nuclear chain reaction, due to the sparse content of the fissile isotope uranium-235 (Cassedy 1998:173). The uranium-235 concentration can be raised by several techniques, the most common are enrichment through gaseous diffusion and gas centrifugation (NEA 2008:60). Both weapons and power depend on having fissile isotopes in sufficient concentration to sustain a chain reaction (Cassedy 1998:173).

Nuclear weapons must use a fuel of extremely high quality, Highly Enriched Uranium (HEU) or plutonium, in order to obtain an explosive chain reaction (Cassedy 1998:173). The fuel for a nuclear fission reactor is very different, usually consisting of LEU in oxide form ( $\text{LEUO}_2$ ) (Cassedy 1998:173). However, the LEU from the Natanz enrichment site is not converted to  $\text{UO}_2$  but stored as Uranium Hexafluoride ( $\text{UF}_6$ ) (Kippe 2009:64). LEU has a lower than 20 % concentration of uranium-235, and HEU has 20 % or higher concentration of uranium-235 (Cassedy 1998).

Although Iran has enrichment facilities, they still need to import uranium ore or yellowcake (uranium oxides,  $\text{U}_3\text{O}_8$  on average), since they do not have enough usable uranium ore for a self-sustained large-scale nuclear power program (Forden and Thomson 2007:6). Yellowcake is converted into uranium hexafluoride ( $\text{UF}_6$ ) through a series of chemical processes in a conversion facility.  $\text{UF}_6$  is then fed into enrichment facilities, in which it is enriched in the isotope uranium-235 (Kippe 2009:51). Iran's capacity to further convert the Low-Enriched Uranium Hexafluoride ( $\text{LEUF}_6$ ) to  $\text{UO}_2$  is not extensive enough, which results in storing  $\text{LEUF}_6$  (Kippe 2009).

Modern nuclear energy reactors usually use LEU fuel (IAEA 2007a). Different nuclear reactors use different concentrations of enriched uranium depending on the specifications of the nuclear reactor for which the uranium is intended. The most common nuclear reactor fuel is enriched uranium between 3 – 5 % (Kippe 2009:37). However, if the proportion of uranium-235 is increased to above 90 %, it is considered Weapons Grade Uranium (WGU) (Kippe 2009:37, Cassedy 1998).

### *2.2.2 The Controversy of Uranium Enrichment in Iran*

Although Iran does not produce HEU now, there is still concern that they could do so. Iran has the technical know-how to continue enrichment of LEUF<sub>6</sub> to weapons grade (Kippe 2009:64). Thus, Iran storing LEUF<sub>6</sub> is providing it with an option to rapidly produce significant amounts of WGU. Already Iran has experience with higher enrichment levels at Natanz PFEP, where they have enriched up to 19.75 % (IAEA 2010). Continuing enrichment of LEUF<sub>6</sub> to higher enrichment levels is a technical process that is easily realized, just by putting the UF<sub>6</sub> back in to the same centrifuges that already enriched the uranium to LEU, or, more efficiently, reconfigure the centrifuge cascades to produce WGU directly (Kippe 2009:64).

In spite of the relevant resolutions by the UNSC and IAEA, Iran has continued enrichment related activities. Iran has continued with the operation of FEP and PFEP at Natanz, and the construction of a new Fuel Enrichment Plant at Fordow (FFEP) (IAEA 2010). Iran's enrichment of uranium up to 20% uranium-235 at PFEP, necessitated an improved safeguards approach, which is now being implemented. In order to verify the chronology and original purpose of FFEP, Iran still needs to provide IAEA with access to relevant design documents and to companies involved in the design of the plant (IAEA 2010). Iran has announced that it has selected the venues for new nuclear sites and that construction of these sites is underway, but has not provided the Agency with the necessary relevant information and access in accordance with Iran's Safeguards Agreement (IAEA 2010).

Similarly, contrary to the relevant resolutions by the UNSC and IAEA, Iran has also continued with the construction of the IR-40 reactor and with heavy water related

activities. IAEA has not been permitted to take samples of the heavy water, and has not been provided with access to the Heavy Water Production Plant (IAEA 2010).

However, as of today, it is not considered proven that Iran is currently developing nuclear weapons. Still, the continued secrecy by the Iranian government, and the parts of the Iranian nuclear program that were not clarified, creates uncertainty concerning Iran's nuclear ambitions. The IAEA is still not reassured that Iran's nuclear development does not have military dimensions. In the Board of Governors report 31 May 2010 it is stated: "While the Agency continues to verify the non-diversion of declared nuclear material in Iran, Iran has not provided the necessary cooperation to permit the Agency to confirm that all nuclear material in Iran is in peaceful activities" (IAEA 2010).

### **2.3 Nuclear Technology, Interwoven in Politics?**

In international politics there has been skepticism and serious concern towards nuclear energy development in Iran. Iran has overcome the technological barrier of uranium enrichment, and therefore actually gained the opportunity of producing nuclear weapons (Kippe 2009:15). The fear now is that Iran has reached the level of technical ability necessary to produce nuclear weapons, Iran will break out of the NPT and actually start a full-scale nuclear weaponization program. Until 2002, there was a technological hurdle for Iran to achieve uranium of weapon quality, however today it is clear that Iran has achieved the expertise and capacity to produce WGU on a significant scale. The international community wants to prevent any possible diversion from the civil nuclear development in Iran to a nuclear military dimension. Iran's nuclear program has therefore been under scrutiny especially since 2002 with



the unraveling of the development of two nuclear facilities, which had been kept clandestine by the Iranian government (Kippe 2009:15). In addition to multiple safeguards breaches throughout Iran's nuclear development. However, Iran has been met with allegations that their nuclear development is an effort to achieve nuclear weapons even before the revelations in 2002.

Although Iran's nuclear energy program was heavily questioned after these discoveries, there is significant history pointing back to countries Iran has tried to cooperate with such as USA, France and Germany who all have to some degree failed to fulfill their promises (NTI 2010a). In an interview with Iran's ambassador Javad Zarif, in 1996, he said to the United Nations that the West cannot expect Iran to sit still when the Iranian government has neither any confidence nor any insurance that in coming years, the pressure by the United States will work on their suppliers (NTI 2010b). The head of the Atomic Energy Organization of Iran, soon after announced on Iranian state television that Iran plans to resume research of nuclear fuel production (NTI 2010b). In recent years it has become transparent that Iran aims to create a source of self-sufficiency in the nuclear field, including a fuel cycle program. The Iranian government has the goal to achieve full-scale nuclear energy generation independently, meaning that they want to implement every technique that is necessary in the production of nuclear energy (NTI 2010a).

The IAEA report on sustainable nuclear development states (IAEA 2001:9):  
“Technology transfer has been an important element for the diffusion of nuclear power technology. Given the unique nature of nuclear power, technology transfer necessarily involves governments, the nuclear industry and financial institutions”. The

report states the importance of nuclear technology transfer and cooperation between governments, industries as well as many institutions. The nuclear technology clearly shows that it is codependent of political development in the pursuit for nuclear energy production. The multiple purpose aspect of nuclear technology causes for additional political measures in transparency and control of nuclear technology expansion.

Winner illuminates that the atom bomb has to be controlled by political measures (Winner 1980:131), as does NFCT because of its sensitive nature. There is the same essential need for control through political measures within most parts of the nuclear energy technology, as the means to avoid nuclear material to be diverted in the effort to achieve a nuclear weapon. As long as there is nuclear technology of any sort there is need for control and supervision of the technology. IAEA has such a function, and supervises the nuclear activity as the means to avoid nuclear weapon proliferation.

Iran has been criticized by the international community for not cooperating extensively with the IAEA, and especially for not implementing the Additional Protocol, which has the intent of enabling the IAEA to detect undeclared of nuclear activities (IAEA 2010).

In spite of the West's demands, the nuclear development in Iran has continued. The controversy of the Iranian nuclear program lies mostly in the enrichment of uranium, and the FEP in Natanz is therefore under heavy observation by IAEA. In October 2006, the Russian Deputy Prime Minister Sergey Ivanov tried to reassure the world that there was no reason to worry about Iran acquiring WGU. He further stated that Iran had launched a second cascade of centrifuges, and that the process was fully controlled by the IAEA (NTI 2010b). The Iranian nuclear enrichments facilities are often not recognized as an accomplishment as well as a great financial investment, but

more as a threat to global security. Although the risk of nuclear weapon proliferation is a valid concern, it is still important to highlight the fact that there has not at this point been proven that the Iran's nuclear development is aimed at the pursuit of nuclear weapons.

Iran's nuclear technology development and political development present a codependent relationship, which is clarified especially because of the possibility of converting the Iranian nuclear technology to nuclear weapon production. The West believes that Iran's intention within nuclear technology is purely to achieve nuclear weapons, and after the discovery that Iran has mastered uranium enrichment technology the political means of trying to stop this possible outcome accelerated. The West demanded Iran to roll back their technological development, first and foremost because of the possible proliferation risk, as well as breaches within their safeguards agreement with IAEA. However, there are many ambiguities that come to surface with this debate. "It is obvious that nuclear technology can be used in ways that enhance the power, authority, and privilege of some over others" (Winner 1980:125).

Iran has sought after uranium enrichment in particular as a technocratic solution to solve their political asymmetry in the world, which to some extent has had the outcome they were looking for. The social impact of Iran's nuclear technology development may be compared to the social impact of the tomato harvester, explained clearly in the excerpt from Winner's article in chapter 1.1. Winner illuminates how significant the relationship between technology and society (politics) may be. He states "technologies may mask social choices of profound significance" (Winner

1980:127). Nuclear technology development is a political choice as much as a technical choice, and with its development it has had consequences in both areas. Through substituting Winner's example of the mechanical tomato harvester with uranium enrichment, it is illuminated that uranium enrichment technology has a similar intertwined technological and politically relationship as the tomato harvester. Iran has chosen to develop uranium enrichment technology instead of relying on importing enriched uranium or nuclear fuel. The actual uranium enrichment machinery implementation in Iran has not merely affected their technology development but also their politics and their relations with the West.

### *2.3.1 The Nuclear Paradox*

Throughout the history of nuclear technology there has been many controversies, and this section aims to describe these controversies. The birth of fission technology, around 1942, revolutionized warfare through utilizing the technology to make atomic bombs, a weapon more destructive than any previous weapon. In the 1950s fission technology also gained a civil dimension, which was to use the self-sustained fission chain reaction in energy production. The civil nuclear energy dimension of the technology won over the support of the international community, which believed that nuclear energy would revolutionize energy production (Bodansky 2004). However, in the 1970s and 1980s the nuclear energy discourse was dominated by a negative attitude towards furthering nuclear development, the main reasons being the safety and the waste management difficulties inherent in the technology (Medvedev 1990). Nuclear accidents such as the Chernobyl accident, in 1986, that had severe consequences for many generations, are some of the reasons for the negative attitude towards nuclear energy technology during that time (Medvedev 1990). There has,

however, been a drastic change in today's nuclear discourse and nuclear energy technology is suddenly regarded as a possible solution to the climate change crisis in the world. The idea is to replace today's energy production through fossil fuels with nuclear energy, which would to a great extent reduce the carbon dioxide (CO<sub>2</sub>) emissions as well as fulfilling the growing energy consumption in the future, and at the same time save the environment. This has become a more common view, although there still is not a consensus about nuclear energy technology's role in the world's future. Nuclear energy has gained a greater status in recent years because it could possibly replace the world's energy generation infrastructure, which is dependent on fossil fuels, and reduce the CO<sub>2</sub> emissions considerably. Because pollution is a stressing matter in the world today, nuclear energy technology has been able to rise again.

The change within the nuclear discourse came with the attempt to unite nuclear energy with the notion of sustainability. The Brundtland Report, published in the late 1980s, defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN 1987). The report states the negative consequences of the world's energy generation infrastructure, and stresses the urgent need to minimize the CO<sub>2</sub> emissions through implementing renewable energy technologies such as wind, water and solar power generation. However, with entering the new millennium many international organizations such as the IAEA, the Organization for Economic Co-operation and Development (OECD) and OECD's Nuclear Energy Agency (NEA) united nuclear energy technology with the notion of sustainable energy generation (NEA 2000). The European Union (EU) has also attempted to unite nuclear technology with the notion

of a sustainable energy development (EC 2007). Nuclear energy development has gained a newfound optimism through fusing it with the notion of sustainability. However, there is a clear difference concerning the discourse surrounding the development of nuclear energy in Iran.

In a report the NEA formulates nuclear power as sustainable stating that as the technology broadens the natural resource capital and is therefore consistent with the objectives of sustainable development related to the creation and effective use of natural assets and their preservation for future generations (NEA 2007:8). There are many reasons for the shift in the discourse of the nuclear energy production field. First, climate change has become a highly legitimate concern in the world, although mostly dealt with in the West. Second, the developing world is catching up, which leads to a constant need for higher energy production. Third, fossil fuels do not last forever. Fourth, there is a constant drive to achieve further technological developments, which leads to higher energy consumption (NEA 2007:8).

The shift in the attitude of the global environment towards nuclear energy technology is because of the notion of being a sustainable energy technology. Although uranium may be compared with fossil fuels since they are both limited resources in the world, it is argued that uranium is not comparable with oil, gas and coal because it is possible to reuse the uranium in the spent nuclear fuel to make new nuclear fuel for the nuclear energy reactors, through closed nuclear fuel cycle technology. Because of the achieved technical ability to recycle the uranium in the spent nuclear fuel, nuclear organizations, such as IAEA, OECD, NEA and EU, have been able to unite the notion of sustainability with nuclear energy. The new technological achievements in the

nuclear energy sector with the concept of a closed nuclear fuel cycle, has made it possible to promote nuclear technology as an effective way of producing clean energy through use of natural assets. There are still many actors who do not agree that nuclear energy and sustainability go together, however, the notion of sustainable nuclear energy may be explained as a newfound nuclear renaissance in the international community.

There has been a clear shift in the nuclear discourse, especially from the optimism surrounding the technology in the 1950s as well as the optimism that came with the attempt to unite the notion of sustainability with nuclear technology in the years after entering the new millennium. Now that the technological hurdle of the uranium enrichment technology has been exceeded, expansion of uranium enrichment technology is an actual fact. As explained above, uranium enrichment technology has a sensitive nature. The aim of the West, the UNSC, and the IAEA has therefore been to restrict the future spread of uranium enrichment technology through strict control of the technology, in an attempt to minimize the risk of proliferation of nuclear weapons.

These restrictions have inevitably limited the commercial availability of enrichment services to a relatively small number of countries and companies. There are many aspects that are legitimate to question concerning the development of nuclear energy, first the aspect of whether or not nuclear energy may be referred to as sustainable, thereafter the aspect of a somewhat monopolized nuclear fuel production in the hands of a few actors, further the aspect of weapon production.

There is a paradox to the optimism surrounding the nuclear discourse above when it

comes to the discourse in especially the Western world on nuclear development in Iran. Throughout the international nuclear discourse there has been a clear trend of skepticism towards nuclear energy development in Iran. The general view of the international community is that Iran may soon achieve the technical ability to produce nuclear weapons, since they already have overcome the technological barrier of uranium enrichment.



### **3 The Nuclear Non-Proliferation Regime**

NPT is the foundation of the global non-proliferation regime. It divides member states into NWS and NNWS, allocating rights and responsibility between them (Suleman 2008:209). It charges the IAEA with monitoring and safeguarding nuclear material to ensure that peaceful nuclear endeavors do not result in weapon proliferation. The NPT is an international treaty, as well as a dispute system designed to manage conflict over the use of nuclear technology between member-states. The system seeks to manage the competing desires of member-states to have access to peaceful nuclear technology and to provide national security. This system must handle disputes over alleged violations of the NPT and IAEA safeguards agreements (Suleman 2008:209).

NPT was signed in 1968, entered into force 5 March 1970 (IAEA 1970), and was extended indefinitely in 1995. At this time, 187 states have signed the NPT, consisting of 182 states that do not possess nuclear weapons, and five states that had tested nuclear weapons before the NPT came into force. NPT focus on preventing the misuse of nuclear materials as well as the establishment of new nuclear weapon free zone treaties in many parts of the world (IAEA 1970).

The IAEA is an international facilitator for cooperation in the nuclear field that seeks to assist in development of peaceful nuclear technology and to inhibit its use for military purposes. It was originally set up as the world's "Atoms for Peace" organization in 1957 within the United Nations. The Agency works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies. The international community has entrusted the IAEA, in NPT's article

III (IAEA 1970), with the authority to safeguard nuclear facilities and to verify the declarations made by states on their nuclear material and activities (IAEA 2001:7). Verification is a process of confirming compliance with treaty obligations. If there is a potentially serious consequence to the breach of a commitment, and if it is strongly suspected that such a breach has occurred, verification has to be all the more stringent (Beach 2009:4). Under NPT, states are required to enter into safeguards agreements with the IAEA, which then has the job of verifying compliance with these agreements (Beach 2009:4). The IAEA is basically charged with verifying that NNWS are not illicitly pursuing nuclear weapons. IAEA safeguards to prevent nuclear material and technology from being stolen or misappropriated for weapons, which includes inspections, remote monitoring, seals, and other measures (King 2006).

All NNWS parties that have significant nuclear activity are required under the NPT to conclude a comprehensive or “full-scope” safeguards agreement with the IAEA. This means that they should declare to the IAEA all their nuclear facilities and all nuclear materials. These are subject to verification, which means they are safeguarded by the IAEA to make sure there is no hoarding of significant quantities of nuclear material for warlike purposes (Beach 2009:4). Traditional safeguards focus on accountancy and control of nuclear materials. In addition to nuclear book-keeping, the Agency also uses passive “containment and surveillance” measures such as tamper-resistant seals and surveillance cameras. This way, the Agency knows, at least in principle, the quantities and locations of all declared fissile material and can verify its non-diversion (Beach 2009:4).

Though IAEA was established independently of the United Nations, under its own international treaty, the IAEA reports to both the General Assembly and the Security Council. The 1997 Model Additional Protocol to Safeguards Agreements (AP) extends the IAEA safeguards authority and allows access to locations not previously subject to IAEA inspections including undeclared facilities (IAEA 2001:7). The purpose of the safeguards system of the IAEA is to provide credible assurance to the international community that nuclear material and other specified items are not diverted from peaceful nuclear uses. The AP is largely viewed as a derived norm for today's safeguards regime. The IAEA's responsibility is to safeguard nuclear technology and make sure that the international society complies with the NPT to prevent the spread of nuclear weapons.

### **3.1 Nuclear Development led to the Establishment of the Non-Proliferation Regime**

There was a need to establish a non-proliferation regime because of the actual technological development within the nuclear field, since nuclear technology has a sensitive nature. The need for a certain political infrastructure appeared with nuclear technology, and was met with the formation of NPT and IAEA as the surveillance infrastructure of nuclear technology. Both NPT and IAEA are a result of the need to handle nuclear technology development. Throughout chapters 1 and 2 the idea that technological and political development are co-produced was presented, and the non-proliferation regime clearly highlights the intertwined relationship between technology and politics in a co-production mode.

Through understanding the intertwined relationship between technological and

political development (change) it is clear that nuclear technology does not affect politics one-sided. However, nuclear technology- and political development share a dynamic relationship where technology and politics coexist as well as being in a constant flux, which makes them have a continuous shaping influence on each other. This dual relationship between technology and politics is a clear trend within the nuclear field, and the co-production idea is straightforward and comprehensive when analyzing the nuclear field. Understanding the interaction between nuclear technology and politics is essential in understanding the controversy surrounding Iran's nuclear development.

The nuclear non-proliferation regime wants to prevent the proliferation of nuclear weapons, and creating NPT and giving IAEA non-proliferation responsibility are political measures taken in the attempt to prevent the spread of nuclear weapons. The technical hurdle of achieving nuclear weapons has been narrowed down because of the growing availability of nuclear technology, especially with the spread of enrichment and reprocessing technology. NWS stand strong within nuclear energy technology, and want to prevent the spread of NFCT as the means to prevent NNWS to achieve possible break out capacity, which means hindering the actual nuclear technology development so that NNWS do not achieve the ability to make nuclear weapons. There is a clear asymmetry regarding availability of the NFCT, and most countries in the world that actually possess the NFCT try to prevent others to choose to develop NFCT through political pressure.

### **3.2 The Flaws in the State of Safeguards of Iran's Nuclear Activities**

With the growth and spread of nuclear technology there are new challenges that have emerged in the political sphere. Nuclear technology development in Iran has caused turbulence in the international community, especially because of the development within NFCT. The surveillance of nuclear technological activity internationally by IAEA, was believed to be adequate when NPT was signed, however, with the expansion of nuclear technology many concerns have risen.

The state of safeguards in Iran can be summarized in one word: 'inadequate'. The country is applying so-called comprehensive safeguards, an almost forty year-old declaration and inspection scheme which is sadly anything but comprehensive. The scheme is based on material accountancy at declared facilities. There are many nuclear activities that fall outside the scope of these safeguards: centrifuge research and development, uranium mining, even the drawing up of new nuclear infrastructure (Persbo 2009:1).

These first safeguards have focused on declared facilities, thereby offered limited protection against the establishment of undeclared fuel cycle facilities (Persbo 2009:1). Iraq had been able to develop an undeclared fuel cycle facility throughout the 1980s, and led to a safeguards reformation, which concluded with the adoption of the AP in 1997 (Persbo 2009:1). The AP is designed to make it possible to detect undeclared facilities more easily in states that have nuclear activity. Additionally, Iran has not accepted the modified Code 3.1 of the Subsidiary Arrangement General Part to Iran's Safeguards Agreement, which implies that Iran must provide design information to the IAEA as soon as the decision to construct a new facility has been taken. As of today, Iran has implemented the 1976 version of Code 3.1, which only requires Iran to provide design information for new facilities no later than 180 days before the facility is scheduled to receive nuclear material for the first time (IAEA 2007b). Furthermore Iran never signed the AP in 1997, and the IAEA therefore had

no knowledge of the undeclared construction of the nuclear fuel cycle within the country, which took the rest of the world by surprise (Persbo 2009:1).

When NPT entered into force in 1970, sensitive nuclear technology was widely considered out of the reach of most countries. This is clearly no longer the case. Access to such technologies has increased particularly over the last few years. As many as 40 countries may now have the technical know-how required to produce nuclear weapons, and the legal regime has not kept pace with these technological developments (Rauf and Simpson 2004). In the absence of an enhanced legal regime, the sole remaining and somewhat fragile barrier to development of nuclear weapons may be a state-party's assessment of its security situation and requirements. Such considerations are rarely fixed but alter over time. In the face of external events, a country that now has no interest in incorporating nuclear weapons into its security doctrine may one day decide otherwise. One of the fallacies of the so-called good guys-bad guys distinction is that occupants of these categories may move from one to the other. Betting on future non-proliferation solely on the basis of the current benign intentions of states-parties dangerously narrows the margin of security (Rauf and Simpson 2004).

The continuing spread of nuclear technology, along with the emergence of underground nuclear supply networks, has led to discussion on revisiting multinational approaches to the nuclear fuel cycle (Rauf and Simpson 2004). The idea had been explored in the 1970s and 1980s but failed to win approval. However, it has gained a new relevance recently amid several new and serious challenges to the nuclear non-proliferation regime, such as the discovery of Iran's uranium enrichment

program, which is now subject to IAEA safeguards. As well as the admission by Abdul Qadeer Khan, the “father” of Pakistan’s nuclear weapon program, that he had organized a secret network to supply Iran and Libya, as well as North Korea, with uranium enrichment technology (Rauf and Simpson 2004).

There are two basic approaches that have been put forward in the pursuit to solve this dilemma; both seek to ensure that the nuclear non-proliferation regime maintains its authority and credibility in the face of these very real challenges. One calls for the further denial of technology to NNWS and the reinterpretation of the NPT’s provisions governing the transfer of nuclear technologies (Rauf and Simpson 2004). In the case of Iran it is unlikely that lowering the technical barrier of sensitive nuclear technology will be successful, there is increasing unwillingness to accept additional restrictions to their right to peaceful nuclear technology under the NPT. The other approach is to use multinational alternatives to national operations of uranium enrichment and plutonium separation technologies, and storage of spent nuclear fuel (Rauf and Simpson 2004).

Iran is engaged in such an agreement, a bilateral agreement with Russia that assures nuclear fuel supply to Iran’s nuclear reactor in Bushehr for the next twenty years (Crall 2010). Although Iran decided to go forth with an assured nuclear fuel supply agreement with Russia does not mean Iran has intentions to eschew from sensitive nuclear technology. In a long-term perspective, Iran’s intentions are to become self-sufficient concerning nuclear fuel fabrication and possess most parts of the NFCT. Iran’s development of uranium enrichment is one significant step that is achieved within NFCT towards becoming self-sufficient.

The IAEA requests Iran to take steps towards the full implementation of its Safeguards Agreement and its other obligations, including implementation of its Additional Protocol (IAEA 2010). In IAEA, Board of Governors Report published 31 May 2010 (GOV/2010/28) it is stated (IAEA 2010):

While the Agency continues to verify the non-diversion of declared nuclear material in Iran, Iran has not provided the necessary cooperation to permit the Agency to confirm that all nuclear material in Iran is in peaceful activities...More specifically, Iran is not implementing the requirements contained in the relevant resolutions of the Board of Governors and the Security Council, including implementation of the Additional Protocol, which are essential to building confidence in the exclusively peaceful purpose of Iran's nuclear programme and to resolving outstanding questions. In particular, Iran needs to cooperate in clarifying outstanding issues, which give rise to concerns about possible military dimensions to its nuclear programme. Iran also needs to implement the modified Code 3.1 on the early provision of design information.

Iran has been met by many different views and demands by the international community because of its development in the nuclear field, especially the West with the US in the forefront has had strong opinions about which path Iran's nuclear energy future should or should not go. As mentioned under 2.1, since Iran had developed an impressive baseline capability in nuclear technologies by the mid 1970s, the US viewed Iran as the potential country in the Middle East that could establish enrichment and reprocessing facilities. However, after the revolution in Iran in 1979, the US has been the most critical actor towards Iran's nuclear development. How nuclear technology in Iran is viewed, and the measures that are viewed as necessary by the international community are in constant flux with the actual nuclear technology development in Iran, but even more by the political situation within Iran and between them and the West. This dual interaction between political change as well as technological change is exactly what the co-production idiom elaborates on.



### **3.3 Nuclear Suppliers Group**

NFCT is an essential part of nuclear technology in the path towards self-sufficiency in the nuclear field. At the same time as NFCT is the technology needed to produce reactor fuel for civil nuclear energy, it may also be diverted to nuclear weapon production. As explained above in this chapter, the dual aspect of NFCT has led to the creation of many political instruments such as IAEA and NPT. NSG is a similar instrument, which aims to prevent nuclear weapon proliferation.

The NSG was established in 1974, and consists of 46 nuclear supplier states, including P5, the five permanent members of the UNSC, which are Britain, France, China, Russia, and the US (King 2006). In addition to the P5, many of the NSG members are other countries that have achieved great success in the nuclear field such as Japan, Canada, Germany, Nederland, Australia, South Africa and South Korea. NSG members have voluntarily agreed to coordinate their export controls, which include supervising transfers of civilian nuclear material and nuclear-related equipment and technology to NNWS (King 2006). In addition to IAEA and NPT, NSG is one more political mean of controlling nuclear technology. The NSG's main objective is, as the NPT and IAEA, to prevent nuclear exports that are disguised as having civil nuclear purposes end up being used to make nuclear weapons.

NSG members are restricted by their NSG membership to conduct nuclear trade with governments that are not NPT member-states, and do not have satisfactory IAEA cooperation. Their members are therefore supposed to report their export denials to each other, as the means to prevent proliferators getting different responses from NSG members (King 2006). NPT member-states with significant nuclear activity who are

satisfactory safeguarded by the IAEA may apply for NSG-membership if they conduct nuclear exports.

The NSG has two sets of Guidelines listing the specific nuclear materials, equipment, and technologies that are subject to export controls. Part I lists materials and technology designed specifically for nuclear use, which includes fissile materials, nuclear reactors and equipment, and reprocessing and enrichment equipment (ASNO 2009, King 2006). Part II identifies dual-use goods, non-nuclear items with legitimate civilian applications that can also be used to develop weapons. Machine tools and lasers are two types of dual-use goods. NSG members periodically review the Guidelines to add new items that pose proliferation risks (ASNO 2009, King 2006). These guidelines restrict NPT article IV rights with reference to proliferation concerns, restricting the actual technology and knowledge transfer in the nuclear field when there are concerns of nuclear weapon proliferation (King 2006). NSG implemented a “catch-all” mechanism, in 2004, that authorized members to block any export that was suspected of having a proliferation agenda even if it did not appear on one of the control lists (King 2006). Through the measures the NSG members enforce one could easily argue that they present explicit restrictions on NPT Article IV rights to nuclear technology, thereby enlarging the divide between the nuclear “haves” and “have-nots”.

The NSG Guidelines require that importing states provide assurances to NSG members that proposed deals are not going to contribute to the creation of nuclear weapons. Potential recipients are also expected to have physical security measures in place to prevent theft or unauthorized use of their imports and to promise that nuclear

materials and information will not be transferred to a third party without the explicit permission of the original exporter (King 2006).

Throughout this chapter it has been highlighted that the nuclear non-proliferation regime consists of a compliance of international treaties as well as accepted conducting norms. NSG contributes to the nuclear non-proliferation regime, by their members voluntarily agreeing to strict guidelines that coordinate their export controls governing transfers of civilian nuclear material and nuclear-related equipment and technology to NNWS. Although NSG members have Guidelines they should comply with, the regime is voluntary, the members may choose to go forth with an export that violates the Guidelines if they believe it favors them politically or economically. Such as Russia exporting nuclear fuel to India in 2001, even though the majority of the NSG members had declared that the shipment would contradict with the Guidelines. Additionally, the US has in recent years supported trade with India, and pressed for the exemption for three years to allow nuclear trade with India (King 2006).

## **4 Iran's Relationship to Nuclear Fuel Suppliers**

In the beginning of this chapter the reasons behind Iran's lack of confidence towards cooperation with the West regarding nuclear fuel supply and nuclear development in Iran is presented. Then the commercial enrichment services in the world are presented, as well as possible future multilateral nuclear fuel supply cooperation suggestions. Throughout the thesis it is illustrated how Iran has been hindered in their nuclear development, and that this has resulted in Iran perceiving that they are being treated unjustly, making Iran worry about how to satisfy future nuclear fuel demands. The West's efforts to try to prevent nuclear activity and development in Iran is one of the ongoing explanations Iran uses to justify that they need to be self-sufficient in the nuclear field, which means the need to implement the whole nuclear fuel cycle, thereby justifying not stopping their enrichment activities.

### **4.1 Iran's Lack of Confidence to Nuclear Cooperation with the West**

In a letter dated 1 March 2010, sent to the IAEA from the Iranian Government, Iran expresses "The root cause of Iranian's confidence deficit vis-à-vis some Western countries on assurance of nuclear supply" (Iranian Government 2010). In the letter Iran points back on certain incidents in the past where Iran has started cooperation with the US, Germany, France, and EURODIF – a multinational company consisting of France, Italy, Spain, Belgium (Sweden withdrew in 1974), who all withdrew from their agreement obligations because of the outcome of the Iranian revolution in 1979. All the countries ended up leaving their agreement with Iran without completing the agreed upon delivery of nuclear fuel to Iran, and leaving Iran short of money and without any nuclear fuel supply at hand (Iranian Government 2010). In the letter it is

stated that these examples are among several evidences of non-compliances of some Western countries, where they have breached their legal and contractual obligations creating confidence deficit on assurances of nuclear fuel supply.

Iran insists that their nuclear development is entirely peaceful, and only aimed at mastering technology to be used to generate electricity (Hafezi 2008). The Iranian regime's agenda in the nuclear field is to be as self-sufficient as possible concerning all aspects of nuclear technology, including the nuclear fuel cycle. Hence, giving up their enrichment technology is not an option. The people of Iran view nuclear energy technology as a development that is their obvious right. Although there are clear divides on political matters in the Iranian population, there is to some degree a united Iran in the quest for nuclear energy (Hafezi 2008). The overall attitude of the Iranian population is positive to nuclear energy development, and that the development is referred to as the country's right to prosper. Iran's President Ahmadinejad invokes metaphors when he speaks to the Iranian population as well as to the world. He has on many occasions said: "Iran's determination to continue its disputed nuclear program has brought major powers to their knees. The Iranian nation will not allow any power to trample even on its smallest national right" (Hafezi 2008). In another speech ahead of an IAEA report on Iran, Ahmadinejad said Iran would ignore calls by major powers to halt sensitive nuclear work that had led to two rounds of UN sanctions (Hafezi 2008):

"The Iranian nation's will to continue nuclear work has won over the will of big powers ... (and) brought them to their knees. Today the IAEA, which is legally in charge of this case, has prepared a report and announced that Iran's activities are legal and there is no diversion. Big powers should respect the agency and its findings" (Hafezi 2008).

One way to analyze the situation is to understand Iran's nuclear dispute with the West as an effort to unite the people and achieve greater political support within their population. This is not a preferred situation for the West. However, through the nuclear dispute the West has to some degree helped Iran achieve a shift from disapproval to more support concerning domestic politics in Iran. The regime has played their cards right in using past incidents to point out the asymmetries the West has enforced on them through not including Iran as an actor on the international nuclear scene. Development of nuclear technology in Iran has become the pursuit of *righteous development*, and it is a common opinion in Iran that national independence and self-sufficiency in the nuclear field is the only path in which Iran may achieve nuclear energy.

There are many reasons why Iran does not want to give up their enrichment facilities. First and foremost Iran cannot rely on what great nuclear countries promise, since previous attempts to cooperate with these countries have failed awfully, leaving Iran as the losing party (Iranian Government 2010). Consequently, further attempts to stop nuclear enrichment on Iranian soil and denial of nuclear technological development hold little likelihood of success.

## **4.2 Competitive Uranium Enrichment**

Only a few companies in a small number of countries possess commercial uranium enrichment technology. Almost all of these companies are either state-owned or have their origins in government programs, and the availability of the technology is carefully controlled, for reasons of national security and non-proliferation (NEA 2008:59). As a result, state involvement in the commercial enrichment sector is high,

and the number of competitors is rather small (NEA 2008:59). There are in effect just four major companies worldwide which presently supply enrichment services to the international market (NEA 2008:59):

- AREVA, controlled by the French Government.
- Atomenergoprom, owned by the Russian Government and which controls the four enrichment plants in Russia.
- Urenco, a British-Dutch-German consortium with mixed state-private ownership with plants operating in each of these three countries.
- The US Enrichment Corporation, USEC, a private-sector corporation formed by privatizing the enrichment operations of the US Department of Energy

In addition, there are smaller scale producers serving domestic markets in China, operated by the state-owned China National Nuclear Corporation, CNNC, and in Japan, operated by Japan Nuclear Fuel Ltd, JNFL. There are also a small number of government agencies in other countries, such as Brazil and South Africa, which have developed enrichment technology, mainly for strategic or self-sufficiency reasons. However, the scales of enrichment in these countries have little or no impact on the commercial market (NEA 2008:60), similar is the Iranian enrichment production (Forden and Thomson 2007:ii).

As highlighted, commercial enrichment sale services are limited to few companies who represent a small fraction of the world. By implementing further restrictions on enrichment technology the outcome may be furthering the gap between enrichment countries and non-enrichment countries. The actual nuclear enrichment situation in

the world is that the commercial availability of enrichment services is limited to a relatively small number of countries and companies. The current situation as well as the futuristic aspect of further enrichment development raises legitimate concern surrounding the enrichment service's future. Is it legitimate that a few actors reserve the right to nuclear enrichment activities? IAEA conveys the necessity of cooperation between governments, industries and financial institutions in developing nuclear power, and that the technology-transfer process is an important element for the diffusion of nuclear power technology (IAEA 2001:9). Uranium enrichment technology contradicts the positive objective to technology transfer within the nuclear field. The resolutions from the UNSC and the IAEA demand Iran to halt their enrichment activities. Since Iran has not complied with their demands, the UNSC has laid sanctions on Iran as an effort to hinder their nuclear development, as a punitive measure with the aim to persuade Iran to stop its enrichment efforts. In addition to the sanctions on Iran, the Nuclear Suppliers Group (NSG) guidelines restrict NPT article IV rights with reference to proliferation concerns, which has restricted the actual technology and knowledge transfer in Iran's nuclear field.

The enrichment facilities in Iran are not at this point in time competitive on a commercial level. The Iranian enrichment facilities have up and running IR-1 centrifuges and plans to produce the more advanced IR-2 centrifuges (Kippe 2009). At this time Iran does not have any reactors that produce electricity, however they have ambitions to expand their nuclear power generation (Forden and Thomson 2007:11). There are many technical lacks within the Iranian enrichment facilities that have to be addressed before Iran may reach enrichment on a commercial level in order to be self-sufficient in nuclear fuel production (Forden and Thomson 2007:12).



Nor does Iran have enough uranium reserves to be self-sufficient in the nuclear field in the long run (Forden and Thomson 2007:6), although wanting to develop the whole fuel cycle is an effort to be as self-sufficient as possible. Iran's enrichment ability is not comparable to the commercial nuclear enrichment companies that offer enrichment services. However, as explained above there are four companies who are represented by six states that dominate the commercial enrichment services in the world, where four of these six countries are NWS. Clearly NWS dominate the commercial nuclear enrichment companies, and there are no commercial enrichment companies that consist of NNWS only. Iran is a NNWS who has implemented nuclear enrichment technology, and Iran therefore has the technical means of developing nuclear weapons (Kippe 2009), as have Japan and Germany, although they are not under scrutiny.

There is need for change in how the international community copes with Iran's nuclear enrichment development. The UNSC's negotiations with Iran have stagnated, which leaves Iran's nuclear development even more closed off to the rest of the world. Without the AP implemented one could argue that Iran more easily could covertly develop nuclear weapons without being exposed. The idea of Iran's nuclear enrichment capability growing into a commercial level may seem of great security risk, however, Iran having codependent relationships in the nuclear field lessens the possibility of Iran establishing and running a covert, military-aimed nuclear fuel cycle.

## 5 Multilateral Nuclear Cooperation

Multilateralism in the nuclear energy field is an attempt to minimize the proliferation risk associated with nuclear development through international cooperation.

Multilateral approaches imply the need for insight and control of the nuclear fuel cycle assets of participating states through internationalization, and giving up the traditional national state control (Rauf and Simpson 2004). The approach encourages greater operational transparency, and the need for nuclear fuel supply assurances when a country chooses to implement nuclear energy technology (Rauf and Simpson 2004). By following multilateral agreements the outcome could serve to strengthen the nuclear non-proliferation regime while not blocking the development of nuclear energy for states wishing to choose that option (Rauf and Simpson 2004).

Traditionally multilateralism presents the idea of multilateral agreements between countries concerning uranium enrichment, plutonium separation and storage and disposal of spent nuclear fuel, instead of single countries controlling all of these aspects (Rauf and Simpson 2004). Placing these technologies under some form of multilateral or multinational control could strengthen non-proliferation (Rauf and Simpson 2004). The core behind a multilateral arrangement is to control and restrict all sensitive technology and to avoid the risks of sensitive technology transfer (Rauf and Simpson 2004). Multilateral agreements build confidence between nations, and may provide enhanced assurance to the international community that the sensitive portions of the civilian nuclear fuel cycle are less vulnerable to weapons proliferation, without singling out “good” and “bad” countries (Rauf and Simpson 2004).

Multilateral nuclear fuel cycle agreements may also have the potential to expand the

use of nuclear energy for peaceful purposes and make it possible for other countries to develop nuclear energy (Rauf and Simpson 2004).

The multilateral approach's goal is to prevent transfer of sensitive nuclear knowledge, and the most common proposal is to black box the uranium enrichment technology, which means keeping the know-how of the technology secret but delivering the finished enriched uranium to the countries who eschew from the technology. Since the knowledge is already acquired in Iran, it is impossible to black box the uranium enrichment knowledge. There are also up and running enrichment facilities that would have to be dismantled if this part of the technology was to be black boxed. However, this would still not be sufficient in the effort to take away knowledge because the scientist and the researchers would still have the ability to continue this type of development, and if their jobs are taken from them they may turn to other options like selling their knowledge on the black market.

The reoccurring idea behind the multilateral approach is that states-parties with nuclear weapons should set an example by using their enrichment and reprocessing plants to provide nuclear fuel to other states that have eschewed these technologies (Rauf and Simpson 2004). The idea is that Iran should give up its enrichment technology and leave the fuel cycle all together. The Iranian government does not trust other countries, and is therefore not acceptant of the idea of being part of a multilateral cooperation that would restrict nuclear development and try to black box enrichment and reprocessing technology.

Having more than one country involved in Iran's enrichment technology could reduce the proliferation risks. In addition, such multilateralism could strengthen non-proliferation norms by requiring nuclear verification and security and safety measures that go beyond existing international agreements and conventions. The partners in such activities could conceivably allow IAEA inspectors "any time, anywhere" access rights, in addition to the use of any verification technologies deemed necessary by the agency, as well as other agreed confidence-building measures (Rauf and Simpson 2004).

### **5.1 Today's Nuclear Enigma regarding Iran**

The UNSC has passed seven resolutions on Iran in the aftermath of the revelation of the two clandestine nuclear sites in Iran (Security Council 2010). Since Iran did not fulfill the demands put forward in the resolutions, which lead to Iran being subjected to four rounds of UNSC sanctions in relation to its nuclear program (BBC 2010). The West is the hardliner in laying forth demands Iran has to comply with, however, during negotiations in the UNSC Russia and China have watered down all the sanctions towards Iran before they have been passed. Although there have been four rounds of sanctions, the reality of the matter is that they do not present an insuperable economic burden, since they do not affect Iran's oil industry (BBC 2010).

The West's highest goal is to prevent that Iran's nuclear development could be geared towards nuclear weapons in secrecy. As highlighted in the previous chapters the international community has supported black boxing Iran's enrichment technology as a way to avoid that Iran has easy access to enrichment technology, because of the possibility to divert the technology and produce WGU. With the existence of uranium

enrichment technology, it involves a possible security risk because of the fatal consequences if a possible diversion actually does take place without being caught in time. Therefore dismantling the enrichment facilities may seem as an attractive solution, however, it is important to recognize that the knowledge and know-how of uranium enrichment does not disappear with the act of dismantling the machines. In the Iranian case the enrichment capability is already established, dismantling uranium enrichment facilities would prolong the ability to achieve WGU, but it would not erase the ability to do so.

#### *5.1.1 The West's View: Stop Enrichment on Iranian Soil*

The nuclear negotiations with Iran seem to have reached an impasse. The international community is still not certain that Iran's nuclear program is solely for peaceful purposes, and the nuclear talks between Iran, the IAEA and the P5 and Germany (P5+1) are expected to continue until all remaining issues have been clarified. The nuclear negotiations were initially established in September 2002 between Iran and the IAEA in the aftermath of the discovery of the nuclear facilities in Natanz and Arak. The Agency was allowed by the Iranian government to visit the uranium enrichment facility in Natanz in February 2003, and by June 2003, the IAEA announced that Iran was in non-compliance with the NPT Safeguards Agreement on a number of instances (IAEA 2003:7). The non-compliance concerned reporting of nuclear material, processing and use of such material, as well as the declaration of facilities where the materials had been stored and processed (IAEA 2003:7). Convincing Iran to comply with the safeguards agreement has been of immense significance to the IAEA, and to gain confidence that Iran is enriching uranium to produce fuel for nuclear power stations, and not to generate fuel for an atomic bomb.

In October 2003, Britain, France and Germany (EU-3) reached an agreement with Iran whereby Iran pledged full cooperation with the IAEA to address and resolve outstanding issues, allow more IAEA inspections under the AP, and to voluntarily suspend all uranium-enrichment and reprocessing activities (IAEA 2004, IISS 2004). In return, the EU-3 agreed to block American efforts to refer Iran to the UN Security Council for past violations of its safeguards agreement (IISS 2004). The implementation of the AP in Iran allowed the IAEA further insight in Iran's nuclear program and additional access rights to Iran's nuclear facilities. Greater admission to nuclear facilities in Iran gave the IAEA the ability to provide assurances regarding the absence of undeclared nuclear activities on Iranian soil. From September 2002 until July 2005, the IAEA and Iran accomplished many achievements in the nuclear discussions (Lodgaard 2010).

Despite great progress in the nuclear talks, the improvements were not protracted. In August 2005, Iran announced they would restart uranium enrichment, which resulted in a breakdown of the negotiations with EU-3 (Iranian Government 2005). The Iranian government also informed the IAEA that Iran would no longer implement the AP. These incidents made the IAEA anxious, and the Agency expressed great concerns by the lack of confidence that Iran's nuclear activities were solely for peaceful purposes (IAEA 2005:2). The IAEA further emphasized the need of understanding of proliferation- sensitive aspects of Iran's nuclear activities, and the Agency mooted the idea to transfer the Iran-issue to the UNSC, seeing that the IAEA was not capable of resolving the nuclear dispute with Iran by itself. In February 2006, the IAEA received a letter from Iran requesting the Agency to reconsider the idea of transferring Iran's nuclear file to the UNSC (IAEA 2006). Iran argued that the IAEA

had no legitimate right to relocate the case, and Iran threatened the Agency with boycott in case the transmission took place. Despite Iran's stipulation, the IAEA transferred the Iran-case to the UNSC, 4 February 2006.

From the Iran-file was transferred to the UNSC until today, the Security Council has implemented four rounds of sanctions resolutions against Iran in an attempt to coerce Iran to be more cooperative. However, the four rounds of sanctions have had very little effect on Iran's position in the nuclear talks. Iran has neither ratified nor implemented the AP, and there is still absence of confidence that Iran's nuclear program is exclusively for peaceful purposes. The divergent positions among the permanent members of the Security Council concerning sanctions against Iran is making matters worse, as stronger sanctions depend on consensus among the permanent members of the UNSC. Given that China and Russia are not endorsing or ensuring the passing of stronger sanctions against Iran, it is assumed that few variations or achievements will be attained in the nuclear negotiations in the nearest future.

Sanctioning Iran was not the only strategy presented by the UNSC. In August 2005, the UNSC in cooperation with the EU-3 presented elements of a long-term agreement with Iran, which included profitable incentives to Iran (Security Council 2006). The positive incentives were offered to the Iranian government in an attempt to encourage them to comply with the demands from the IAEA. The incentives were supposed to be covered in a comprehensive agreement between Iran and the UNSC, which presumably would be developed over time. The incentives Iran was offered from the UNSC mainly implied fuel assurances, Iranian access to the international economy,

markets and capital, building of new light-water power reactors in Iran, energy partnership between Iran and the European Union, as well as other incentives (Security Council 2006). In return, Iran had to comply with three criteria: Firstly, Iran had to commit to addressing all outstanding concerns with the IAEA. Secondly, Iran was obligated to suspend all enrichment-related and reprocessing activities. Thirdly, Iran had to implement the AP (Security Council 2006). In the end, Iran decided to turn down the offer from the UNSC. The immediate consequence of the Iranian refusal was implementation of the UNSC's sanctions against Iran.

The West views the current nuclear situation in Iran as dangerous because the IAEA does not have enough insight in Iran's uranium enrichment activities, creating uncertainty around Iran's nuclear ambitions. It is assumed that greater transparency will not be achieved as long as Iranian leaders have not implemented the AP.

#### *5.1.2 Iran's View: Their Inalienable Right to Enrich Uranium*

Iran's nuclear program has become a prestige project for the Iranian elite. Interestingly enough, this is not only the standpoint of the Iranian elite, but the overall attitude towards Iran's nuclear development has been positive within the country. Both the majority of the regime and the majority of the people of Iran view Iran's nuclear development as Iran's right as a nation. The nuclear program has not only put Iran on the map as a significant power in the Persian Gulf and the Middle East, but also become a symbol of Iran's national pride and sovereignty (Perthes and Wegner 2006). UNSC's ineffective sanctions and vague incentives have not been sufficient to convince Iran to act in accordance with the IAEA's requirements and the UNSC's demands. The nuclear program is so valuable to Iran that any solution in the nuclear



dispute will have to include some incentives that surpasses the value of the Iranian nuclear program. Such incentives will be extremely difficult to agree on.

As much as the UNSC has doubts about the truth behind Iranian nuclear development, Iran has as many reservations to cooperation with UNSC countries and question whether or not their promises will be kept. Iran's nuclear development has been based on the highest degree of self-reliance possible, and their nuclear enrichment ambitions are also a reflection on being able to stand alone in their quest towards attaining nuclear energy. As pointed out throughout chapter 4, there are few nations that offer enrichment services, and most of these nations are cautious on cooperating with Iran. In addition, these nations are all restricted to cooperate with Iran concerning nuclear technology through their NSG membership, and often also restricted because of UN sanctions towards Iran. Iran therefore clearly has legitimate concerns to trust any possible cooperation with any of these actors.

Regarding an inclusion of new actors in the nuclear negotiations, President Ahmadinejad announced in June 2010, that "Talks must involve an expanded group of nations beyond global powers China, France, Germany, Russia, the United Kingdom and the United States" (NTI 2010b). The statement came subsequent to Iran, Turkey and Brazil approving an agreement on uranium exchange. Inclusion of new actors may be positive in the nuclear negotiations with Iran.

As the preeminent power in the region, in search for nuclear technology and higher international status, Iran has not been willing to obey the UNSC's nuclear demand. The Iranian government expects to be treated as a major power, and it is not

inconceivable to believe that the lack of triumph in the nuclear negotiations reflects Iran's pursuit for that recognition (Lodgaard 2010). "Alleviating the asymmetry by recognizing Iran as an important actor in the Middle East is an important prerequisite for constructive management of the nuclear problem" (Lodgaard 2010). In a similar way, Perthes and Wegner have stated that a negotiated solution must respond to the Iranian elite's demand for international recognition. They further argue that such recognition will be necessary regardless of who governs Iran.

"Iran assumes it is by right the preeminent power in the Persian Gulf and the greater Middle East region. It has the largest population, largest land mass, largest military and oldest culture and civilization. It believes it is the economic engine of the region and the most innovative in application of science and technology" (Yaphe 2008).

Acknowledging Iran as a powerful actor on the international scene has been difficult for some countries, but desirable for others. Iran's rising influence in the Persian Gulf and the Middle East is indisputable, but the main question is how to deal with a rising Iran. Washington has been striving to contain Iran, as a way of reducing Iran's influential power. Beijing and Moscow have, on the other hand, advanced their relations with Tehran considerably during the same period of time (Gundzik 2005). Proposals on how to deal with Iran are many. Within the UNSC, the main procedure to deal with a rising Iran has been to force Iran to close down all enrichment related activities, in fear of Iran becoming a nuclear power and in response to its non-compliance to its Safeguards Agreement.

## **5.2 International Fuel Bank**

A proposed international fuel bank under IAEA control is one specific multilateral approach, with the effort to secure non-proliferation and at the same time contribute

to the expansion of enrichment technology in the world. By providing a secure and reliable supply of the fuel needed for nuclear power generation, a nuclear fuel bank would strengthen the nuclear non-proliferation regime through an assurance of supply and reliance on the nuclear fuel market (IAEA 2009).

“The proposed fuel bank is a bold agenda and it is clearly not going to happen overnight. But bold measures, including assurances of nuclear fuel supply and multi-nationalizing sensitive parts of the nuclear fuel cycle, are vital if we are to enlarge the contribution of atomic energy to peace, health and prosperity throughout the world while curbing the proliferation of nuclear weapons and eliminating them altogether” (IAEA 2009).

The idea is that if a country or company is not able to buy fuel on the commercial fuel market, that country or company would be able to purchase the fuel at marked value from the international fuel bank without being discriminated. The idea of an international fuel bank in the nuclear field is bold, however, the actual practicality of realizing the idea is complex and difficult. The international fuel bank criteria are that the member countries act in accordance with the NPT and the AP as well as willingly forgo their right to develop the nuclear fuel cycle. The NWS would then use their enrichment and reprocessing plants to provide nuclear fuel to other states that have eschewed these technologies.

### **5.3 Opponents of Multilateral Approaches**

Opponents of multilateral approaches point to loss or limitation of state sovereignty and independence of ownership or control over a key technology sector (Rauf and Simpson 2004). Within a multilateral context, however, this can be done at a larger stage than unilateral denial policies, allowing countries greater access to truly peaceful nuclear technology while discouraging them from developing independent

national programs either overtly or covertly that can lead to weapons development. To meet the twin objectives of non-proliferation and “multilateralization,” nuclear facilities can be provided to partners in a “black box” mode, the technology holders construct and operate facilities that are managed and operated multilaterally, without technical know-how being spread. A suggested fuel bank is an attempt to assure fuel supply to countries that are willing to forego their right to develop enrichment technology. The fuel bank agenda is to avoid monopolistic fuel supply situations and to secure future development of uranium enrichment technology by restricting and controlling the technology, in an attempt to prevent the spread of the technology to those who may wish to use it for unauthorized purposes (Rauf and Simpson 2004).

This proposition may be attractive to countries that have not fully developed enrichment capabilities, however in Iran’s case this is not an acceptable option. The West has excluded Iran from taking part in the international nuclear scene even when Iran allowed the IAEA to apply AP from November 2003 to February 2006, the West still did not view Iran as a trustworthy actor in the nuclear field (Lodgaard 2010). Although Iran was cooperating with even more comprehensive inspections than any other country in the world in this period (Lodgaard 2010), still Iran’s nuclear development was not acceptable in the views of the West, who insisted that Iran halted all enrichment related activities until the IAEA was ready to provide Iran with a clean slate.

Multilateral cooperation on the nuclear fuel cycle may seem as a good idea, however, the idea is at this point in time hard to realize because of the trust issues between countries, as well as the strive after power and control. Iran wishes to reach self-

sufficiency in the nuclear field, and does not have any intention to eschew from its right to develop certain parts of the nuclear fuel cycle, in an effort to possibly be a part of a multilateral assured nuclear fuel supply cooperation.

#### **5.4 Russian-Iranian Fuel Deal**

Germany's Kraftwerk Union had begun construction of two reactors at Bushehr in 1975 under commission by the Shah (Crall 2010). With Iran's 1979 revolution, the new Islamic government discontinued payments, and the German firm then backed out of the contract (Crall 2010). During the Iran-Iraq war, Iran showed a newfound interest in finishing the nuclear development in Bushehr, and Kraftwerk Union agreed to restart their work in Bushehr, but they were not able to do so at that time as the plant was repeatedly targeted by Iraqi air strikes. However, after the Iran-Iraq war, Iran was in the midst of increasingly strained relations with the West, and Germany did not restart their construction work at Bushehr. Kraftwerk Union left the agreement, with the first reactor nearly completed and the second only partially built (Crall 2010).

Iran sought after new partners to finish the project, and Moscow agreed to take over construction of the first reactor in 1992 with work beginning three years later, but there were repeated delays in the construction work. Russia has publicly cited that there have been technical and financial reasons for the setbacks, but diplomatic sources have said that Moscow held up construction to place pressure on Iran over its nuclear program (Crall 2010). Iran's first nuclear power reactor in Bushehr was completed and activated 21 August 2010 when Russian and Iranian technicians began loading Russian-provided fuel. The reactor, which is safeguarded by IAEA, is

scheduled to begin producing electricity in the coming months (Crall 2010).

Construction of the Bushehr plant has taken place on and off for the past 35 years, by two different countries, and under two different Iranian governments.

Russia has agreed to fuel the reactor for at least 10 years, providing both the enrichment and the fuel fabrication. Iran claims that it is enriching uranium to ensure that the Bushehr plant, as well as other reactors it intends to construct, have long-term fuel supplies. The proprietary specifications for fabricating the Bushehr plant's fuel are owned by the Russian state-owned nuclear conglomerate Rosatom (Crall 2010).

The Bushehr reactor operates on uranium fuel enriched to about 4 percent of the fissile isotope uranium-235. Under normal operations, light-water reactors (LWRs) such as the Bushehr plant do not produce plutonium of a quality appropriate for nuclear weapons. The reactor operations can be adjusted to produce better-quality plutonium, but such activities would be detectable by IAEA inspectors because they would entail changing fuel much more frequently than commercially optimal operations would require (Crall 2010).

In order to separate plutonium from the reactor's spent fuel, Iran would need a reprocessing capability, which it is not known to have. Moreover, Iran is currently constructing a heavy-water reactor at Arak that is far more suited to weapons-grade plutonium production (Crall 2010).

All NNWS that are parties to the NPT must subject their nuclear activities to IAEA inspection and not seek nuclear weapons. A recent State Department report on

compliance with international arms control agreements found Iran to be in non-compliance with its IAEA safeguards and to have been in violation of its NPT commitment not to seek nuclear weapons, at least in the past (Crall 2010). Although UN Security Council sanctions prohibit the transfer of nuclear goods and technology to Iran, they allow exemptions for assistance related to LWRs. Russia sought the exemption to allow continued work on the Bushehr plant (Crall 2010).

The US opposed Russia's construction of the plant for many years, but Washington dropped its opposition in 2005 after Moscow secured an agreement from Tehran to return the spent fuel from the reactor to Russia. The 2005 arrangement helped to address US concerns that Iran might reprocess the spent fuel to produce plutonium for weapons (Crall 2010). Since 2005, many Western nations, especially the US, have characterized the Bushehr plant as the ideal model for Iran's nuclear program, highlighting that Tehran's arrangement for fueling the plant means that Iran does not need to enrich its own uranium (Crall 2010).

The West has argued that Russia's support for Bushehr underscores that Iran does not need an indigenous enrichment capability if its intentions are purely peaceful (Crall 2010). Many Western countries are putting political pressure on Iran through using the success of the Russian-Iranian fuel deal as an effort to make Iran halt their uranium enrichment activity. Israel has criticized the decision to support the Russian-Iranian fuel deal, conveying that Iran should not benefit from nuclear energy while avoiding non-proliferation obligations (Crall 2010). At the same time, Israel has not signed the NPT, and is one of three countries in the world that have never been signatories to the NPT, the others being India and Pakistan (North Korea withdrew

from the treaty in 2003).

However, Iran has characterized their cooperation with Russia as an act of defiance against Western pressure. “Resistance of the Iranian nation...led to the completion of the Bushehr power plant project,” said Atomic Energy Organization of Iran chief Ali Akbar Salehi in a ceremony marking the fuel loading 21 August 2010 (Crall 2010).

## **5.5 Nuclear Technology’s Future in Iran**

In the previous chapters the thesis has pointed out how the Iranian government perceives their political position as unbalanced in the world, particularly in regards to the West. Iran has gained higher status politically through developing nuclear technology, mostly in the Middle East but also internationally. Iran has been reluctant to negotiate with the West, the UNSC, and the IAEA concerning uranium enrichment technology, and their negotiations have been deteriorating. Essentially the actors set forth two different conditions that conflict with one another, as highlighted throughout the thesis. Firstly, the West want to achieve black boxing of the uranium enrichment technology in Iran, because they fear Iran may have nuclear weapon ambitions. Secondly, Iran wants to achieve a leveled out political reality and not the political asymmetry it has been exposed to. Basically, the actors on each side of the specter view that their condition has to be met, and if one condition is realized, the consequence is that the other one is not realized. Therefore neither one of the actors are willing to negotiate extensively concerning uranium enrichment in Iran, because they do not view the possible outcome of realizing the opponents condition as in their interest.



## **Part Three**

### **6 The Co-production of Technology and Politics in the Nuclear Field**

Throughout chapters 2-5 the focus has been to present a balanced picture of both technical and political development in the nuclear field, with emphasis on Iran's nuclear development. However, it is important to regain the focus of the main objective of the thesis, which is to show how technology and politics in the nuclear field are co-produced. This chapter attempts to systematically go through the findings in chapters 2-5 and point out co-production of technology and politics in the nuclear field.

The West perceives Iran's nuclear development as a development with a military dimension, and argues that by prohibiting Iran's uranium enrichment activity and development it will secure non-proliferation of nuclear weapons. Iran does not view nuclear technology as a future energy generation option if it means that they have to depend on Western cooperation for nuclear fuel supply and nuclear technology transfer. Therefore technological self-sufficiency is of great importance in Iran's development of nuclear technology. At the same time the West has united nuclear technology and sustainability and attempted to tackle pollution and climate change through increasing nuclear energy production. This development has contributed immensely to improve the status of nuclear energy, and legitimized nuclear technology development in the political arena. But the West does not include all countries in this newfound nuclear renaissance, which is supposed to secure

sustainable energy production for future generations, and according to the West Iran's nuclear technology may not be united with the sustainable nuclear notion. This shows that the same technology has totally different meanings in different contexts.

This chapter discusses how scientific (and technological) knowledge effects political development, as well as the other way around. Co-production of technology and politics has already been presented as the analytical framework, now the thesis will mainly use Lidskog and Sundqvist's (2002) elaboration of Jasanoff's four mechanisms, presented in section 1.1, when uniting the case with the theory. The thesis will attempt to use these mechanisms as analytical tools to describe the relationship between technology and politics, and identify co-production of technology and politics in the development of nuclear technology in Iran and the West.

Before analyzing how scientific (and technological) knowledge and political development are linked, it is helpful to define scientific (and technological) knowledge in Iran's nuclear development and in the international community. The scientific (and technological) knowledge that is significant in the thesis is all technology connected to nuclear power, and Iran's enrichment technology is especially in focus. From this point on scientific (technological) knowledge is referred to as nuclear technology. The next chapter will further elaborate how nuclear technology is influential in Iran's and the international community's political development, and how technology and politics are co-produced in the nuclear field, with a special focus on Iran.

## **6.1 Nuclear Technology Supports Politically Accepted Forms of Discourse and Reasoning**

Jasanoff's first mechanism explains how scientific knowledge (nuclear technology) may influence politically accepted forms of discourse and reasoning. This section aims to point out how this mechanism occurs in Iran's and the West's nuclear discourses.

As explained in section 2.3.1, there has been a clear shift in a positive direction regarding nuclear energy technology on the global arena. This shift has been possible through technical innovation in the NFCT, the technical means of reusing spent nuclear fuel. Moreover, it is important to emphasize on the significance of uniting nuclear energy with the notion of sustainable energy development. The international, especially the Western, political discourse has heavily focused on the importance of achieving a sustainable energy development in the world. Nuclear technology has therefore tried to fit into this political framework. Because sustainable development is a politically accepted form of reasoning, nuclear technology has to develop further in order to make nuclear technology attractive in a sustainable framework, hence making it possible to legitimize nuclear technology politically.

Uniting sustainability and nuclear technology has been dependent on development within both technology and politics. Through scientific knowledge that explained the consequences of pollution, awareness of sustainable energy development was raised, and it became supported both scientifically and politically. Further, the technique of reusing spent nuclear fuel had to be in place in order to politically support nuclear

technology as sustainable. The development explained above is an example of co-production of technology and politics in the nuclear field.

The renewed optimism concerning nuclear technology is because international politics support the notion of sustainable nuclear technology, which is explained in section 2.3.1. However, the West does not support nuclear technology development in Iran, which contradicts with their support for sustainable nuclear technology elsewhere. The West criticizes Iran on many technical and political matters, such as supporting Hezbollah and Hamas, extreme Islamic fundamentalist groups (Bahgat 2007), as well for lack of democracy in their politics, violation of human rights, discrimination of women, and religious discrimination (Mayer 1994). The dual aspect of nuclear technology, the way in which uranium enrichment may be used for both nuclear fuel fabrication as well as WGU fabrication, creates one more way in which the West may criticize the Iranian regime.

Although the West has criticized Iran's political development on many aspects, after the exposure of Iran's enrichment site in Natanz the West has emphasized their critiques of Iran's nuclear technology development. The West has stressed that Iran's nuclear technology is the biggest political problem concerning Iran's political development. Nuclear technology has become a political tool in the political discourse, both by the West as well as Iran. The West attempts in a way to empower itself as the responsible actor that prevents nuclear weapons proliferation disguised as nuclear technology development. The way the West assesses nuclear technology in Iran is influenced by their political view of Iran, and condemning nuclear technology in Iran is one more way for the West to stress that they are right and Iran is wrong.

The West attempts to portray Iran's nuclear technology as a negative development to highlight the notion of "good" (the West) versus "bad" (Iran). Iran's political discourse aims to explain their nuclear ambitions as the need for greater energy production for their growing population, and their reasoning in the political discourse is emphasized on nuclear technology development as a scientifically justified option that would fulfill their future energy demand. Iran tries to portray the West as hooligans who bully nations who do not support Western political interests.

Iran claims that the West wants Iran to be dependent of them, and that they want to control their technological development as the means to achieve this goal. The West has sought to the idea of multilateralism as the way of political reasoning to achieve control of Iran's uranium enrichment ability within their nuclear technology development. Multilateralism seeks to prevent the spread of sensitive NFCT, such as uranium enrichment, as an effort to avoid nuclear technology geared towards nuclear weapons proliferation. UNSC politically support multilateral approaches in the nuclear field, however it is important to highlight that all five of the UNSC permanent members already have national NFCT programs as well as nuclear weapons. They consider themselves as the location in which the multilateral nuclear facilities should be located.

In both the West and Iran's political discourses Jasanoff's first mechanism have been illuminated, and it has become transparent that nuclear technology has influenced accepted forms of political reasoning in both the West and Iran. Nuclear technology development has been used as a political evaluation tool in different discourses, and

the international community has accepted the use of nuclear technology as reasoning for or against a political issue.

## **6.2 Communities with the Privileged Right to Formulate Policy, Ratify Nuclear Technology**

This section aims to explain how Jasanoff's second mechanism, which states that communities with the privileged right to formulate policy ratify scientific knowledge (nuclear technology), also occurs in nuclear technology development. There are many examples in the nuclear field where either single actors or a group of actors actually have made a policy officially valid. The thesis attempts to highlight how policies have influenced nuclear technology development and ratified it in the West and Iran.

The nuclear non-proliferation regime is a result of the need to formulate policy within technological development in the international community. There is an intertwined relationship between technology and politics in the nuclear field that is greater than in many other technologies because of the dual use of nuclear technology. Because of proliferation risk of nuclear weapons, there is an even more significant need for an international understanding and norm within nuclear technology development. NPT is an international treaty that is viewed as the norm of conduct in the nuclear field. As mentioned in chapter 3, 187 states have signed the NPT including Iran. However, there is a difference between the extents of political influence a certain state has in the nuclear community, even between NPT member-states, depending on the member-state. The NWS especially have a great influence in the nuclear field, because of their leverage through their nuclear weapons. The difference between weak and powerful states is not directly defined by the co-production idiom, however it is clearly treated

by the theory as political interaction. The theory's function is to explain the interaction between technology and politics, and the amount of political power different states hold does affect the relationship between technology and politics. The intent of the co-production idiom is to function as a tool that helps explain how technological and political factors affect each other. The co-production idiom is an approach that explains the interaction and intertwined relationship as a two-way flux between technology and politics.

Throughout chapters 2-5 the political and technological relationships in the nuclear field are explained. In chapters 3 and 4 especially we see how the political development has had a deterrent factor on technological development in Iran's nuclear development through preventing technology transfer and fuel supply to Iran. Lack of nuclear fuel availability and prevention of technology transfer in the nuclear field is a direct consequence of political decisions, which has had a negative outcome on Iran's technical ability. Many countries, with the Western countries in the forefront, have joined force to formulate policy to avoid technology transfer to countries that are not internationally trusted. The development of nuclear technology is to a great extent affected by NSG as a political force that has prevented especially Iran's nuclear development. Countries that are part of NSG have agreed to limit their cooperation in the name of non-proliferation of nuclear weapons, which also has affected technology transfer for development of civil nuclear energy technologies. Access to certain essential technical parts and materials is denied by the NSG-member states. The reason for this denial is to prevent possible nuclear weapon development, however, it also affects the development of a civil nuclear program and prevents civil nuclear energy development on a national level. There has been a

constant flux between technology and politics in the nuclear field; however, the dominant trend has been that countries that do have the technology do not want countries that do not have the technology to achieve it.

IAEA is also a result of political development in the nuclear field, as the international organization responsible for surveillance and verification of significant nuclear development. The IAEA function is both to verify that all state-parties conduct in accordance to the nuclear norm, in addition to assist with technical development in the nuclear field. Again the co-production of technology and politics is illuminated, as well as the codependency of technology and politics in the nuclear field.

With constant enhancements within nuclear technology new challenges appear in the political arena. Because of growing availability of nuclear technology, the political aspect of nuclear weapon proliferation is also growing. There is a growing need for a greater verification and surveillance system globally, and we see co-production of technology and politics as the means to cope with these challenges. The technology has to enhance in order to reach political acceptance, and technology and politics are in constant flux in the nuclear field.

The co-production idiom “challenges assumption of science as an autonomous sphere whose norms are constituted independently of other forms of social activity. Rather, the resolution of any significant new problems in science is seen as requiring situated and specific (re)structuring of social order, without which scientific authority itself would be put in jeopardy” (Jasanoff 2004:30). Jasanoff claims that science cannot be described as an independent and isolated from other social activities. Iran’s nuclear



technology development has been entwined with political decision-making, and international politics has had negative consequences on Iran's nuclear development, which supports Jasanoff's assertion. The technical quality of the nuclear machineries in Iran's nuclear field have not been of the same quality as the newest and most advanced technology in the global nuclear field. West has prevented Iran from attaining the newest and most advanced machineries and knowledge in the nuclear field through political means. Iran's civil nuclear program has therefore not been as fruitful as it could have been from a technological perspective. Iran is clearly excluded from being an actor in the nuclear field with the privileged right to formulate policy and ratify nuclear technology. The communities with the privileged right to formulate policy and ratify nuclear technology consist of the Western World and their allies, who through politics have steered which actors may or may not develop nuclear technology. The West is the dominant actor politically because they have the privileged right to formulate policy and ratify nuclear technology, and they have defined nuclear energy as a good solution to sustainable energy production. However, Iran's nuclear development does not fit into their framework of nuclear energy as good, therefore the West has steered their politics towards prevention of nuclear technology development in Iran which has had a direct lagging effect on Iran's nuclear technology development.

With the above facts at hand, we may argue that although nuclear energy technology has been invented, it alone does not mean that communities may successfully implement this technology. When implementing nuclear energy technology many actors have to be involved and agree on the development of the infrastructure and the practicalities of how to carry out the implementation. Basically, many actors have to

agree on decisions that have to be made in the quest for nuclear energy. There are many decisions that have to be made before the nuclear energy production may start up, the thesis will try to point out some of these decisions. First, the nation that aims to start up nuclear energy production has to decide whether they want an exclusive national nuclear program or cooperation with private companies, and decide who contributes with the financial means. Further, decisions have to be made concerning which nuclear reactor to develop and choosing machinery and materials, and how to attain the nuclear fuel needed for the reactors, which means whether or not to implement the whole NFCT or buy nuclear fuel. Cooperation between many actors has to be in place, such as cooperation between governments, institutions, suppliers and investors. These actors have to agree on how to develop and implement nuclear energy technology.

However, communities that do not have the *privileged right to formulate policy* within nuclear technology, and thereby not realizing Jassanof's second mechanism, do not cooperate successfully with most of the actors mentioned above. The reason for this is that the actors in the nuclear field with the *privileged right to formulate policy* do not cooperate with actors who do not have this right. Iran as an actor that does not have this right, exemplifies how their nuclear energy technology is colored by this shortcoming.

### **6.3 Economic Interests and Government support Nuclear Technology**

In the following section the thesis points out how Jasanoff's third mechanism, which states that economic interests support development in the society based on scientific knowledge (nuclear technology), occurs in nuclear technology development. In many

instances economic interests have been the force behind the support for nuclear technology development. The thesis attempts to highlight how economic interests have supported nuclear technology development both in the West and Iran.

Economic interests and government support of nuclear technology in Iran has developed a common agenda, which is to be both independent economically and technically in the nuclear field. However, this agenda is contradicted by the Russian-Iranian fuel deal that is fueling Bushehr nuclear power plant. Although the Iranian government is fronting their nuclear development as a ground-breaking technical achievement, the reality of the matter is that they are politically hindered to participate in the international nuclear field, which has had negative consequences for their technical achievements. As explained in chapter 4, Iran is neither technically nor materially self-sufficient in the nuclear field, which is a result of political measures taken by especially the West to hinder Iran to attain the level of technical and material self-sufficiency. Still, technological development in Iran's nuclear field has played the role of a visible consensus builder with convergent economic interest of business and government support.

The Iranian regime has expressed many reasons for why they want to produce nuclear energy. One of the main reasons they have put forth is that they want to be able to lift Iran's economy, by replacing some of their electricity generation through oil and gas with nuclear energy generation. When lessening their own use of their oil and gas reserves in the energy production process they may extend their oil and gas export, which could lift Iran's economy considerably. As mentioned earlier, Iran also has a

rapidly growing population and therefore needs to expand their level of electricity generation.

In the West, each government had national nuclear programs that supported the development of nuclear energy technology both financially and politically (Bodansky 2004). Both economic interests and government support made nuclear energy development feasible in the West. Today private companies have attained more influence in the nuclear field in the West; however, the governments have maintained their political influence in the field.

#### **6.4 Nuclear Technology is part of a Technological Culture where Technocratic Solutions are favored**

Jasanoff's fourth mechanism explains how scientific knowledge (nuclear technology) may influence technocratic solutions to political problems. This section aims to point out how this mechanism occurs in Iran's and the West's nuclear discourse.

Throughout chapter 2-5 there are examples where nuclear technology is clearly part of a technological culture where technocratic solutions are favored. As emphasized throughout the thesis development within nuclear technology has gained profound support in the overall culture of the Iranian population. To eschew from enrichment technology is not viewed as an option by the Iranian government, and the people of Iran do not understand why the West demands their country of this, and they believe it is their right. Development within nuclear technology in Iran has to some degree become a symbol of prosperity, and the Iranian government has been able to gain political influence within Iran because of their technological achievements. The

Iranian regime has had countless problems with both the outside world as well as their own population (Dehghan and Black 2010). Iran has attempted to use nuclear technology development as a technocratic solution to strengthen their politics inside and outside of Iran.

The West has somewhat succeeded to use nuclear technology as a technocratic solution to cope with the dilemma of the negative consequences of greenhouse gas emissions and climate change, highlighted in chapter 2. Through uniting the notion of sustainability with nuclear energy production the West has been able to argue that limiting energy production is not necessary in coping with climate change. However, the West has argued that nuclear energy is the way to solve these problems without changing the Western lifestyle.

## 7 Conclusion

The relationship between technology and politics as codependent factors in the nuclear field has been illuminated through Iran's uranium enrichment technology. Enriched uranium may either be used to produce nuclear fuel for nuclear reactors or to produce WGU that fuels nuclear weapons. This dual use aspect adds to the already complex relationship between technology and politics in the nuclear field. The thesis has highlighted how uranium enrichment is a technical artifact that is needed in the quest to achieve self-sufficiency in Iran's nuclear development, and at the same time it is a political tool for the Iranian government to strengthen their position in the international community as well as within their own population.

Iran's development of uranium enrichment is perceived as a necessity by the Iranian regime because they want to achieve a state of self-sufficiency in the nuclear field. The West, however, attempts to convince Iran to black box their uranium enrichment technology, and in return promises to cooperate with Iran on nuclear fuel supply. Iran does not want to be dependent on nuclear fuel supply from other actors in the future, especially not the West. The West and Iran are both unwilling to trust one another, and they both require fulfillment of certain demands, which are opposites, when negotiating cooperation proposals in the nuclear field.

Through analyzing Iran's nuclear development by means of the co-production framework, it has been uncovered how nuclear technology and politics interact in nuclear technology development both in Iran as well as in the West. The thesis illustrates that Jasanoff's four mechanisms, which describe co-production of

technology and politics, do occur in both Iran's and the West's nuclear technology developments. However, the same technology has totally different meanings in different contexts, and the thesis has pointed out how the West unites nuclear energy with the notion of sustainable energy development but at the same time excludes Iran from this development. Jasanoff's co-production idiom has illuminated how the interactions between nuclear technology and politics have affected each other.

Some interesting observations were made, in chapter 6, when analyzing the interaction between nuclear technology and politics in the development of Iran's uranium enrichment technology. Notably, that uranium enrichment technology represents more than a pure technology. It has become a political tool that represents two completely different "truths". Through political reasoning nuclear technology has, from a Western perspective, become a political tool that represents either "good" or "bad", but from an Iranian perspective it represents political power. This conclusion makes one shift focus from nuclear technology as being about pure technology to represent a promise or a threat and most of all political power. The analysis also shows that since Iran does not have the *privileged right to formulate policy*, their nuclear energy technology has suffered from a technological perspective. It is important to understand that nuclear technology development has different consequences both technologically and politically depending on the actor in question.

Within international politics there is much emphasis on Iran's enrichment activity, and how to cope with its development. The thesis has highlighted the interaction between nuclear technology and politics, and explained how uranium enrichment in Iran is not pure technology but also politics, which has challenged the traditional

interaction between Iran and the West. One may therefore conclude that the development of uranium enrichment technology has become a tool to achieve higher status in the international community. Since the technology of uranium enrichment has gained political leverage, further research could unveil in what ways Iran may achieve political leverage through other means without developing sensitive nuclear technology. Iran has gained a somewhat empowered political state through their uranium enrichment technology, and it could be fruitful for nations to consider other ways to achieve cooperation with Iran, without stripping Iran of their newly attained political position. Also, it could be beneficial to further examine in what ways achieving political leverage in Iran through other means would effect Iran's uranium enrichment development and nuclear ambitions.



## References

- ASNO, Australian Safeguards and Non-Proliferation Office, (2009), *Nuclear Trade outside the Nuclear Suppliers Group*, published January 2009.  
(Reading date 22 November 2010) URL:  
[http://www.icnnd.org/Documents/ASNO\\_Nuclear\\_trade\\_outside\\_NSG.pdf](http://www.icnnd.org/Documents/ASNO_Nuclear_trade_outside_NSG.pdf)
- Bahgat, Gawdat (2007), *Iran and the United States: The Emerging Security Paradigm in the Middle East*, Parameters, Summer 2007, Vol. 37, No. 2, pp. 5-18.  
(Reading date 13 November 2010) URL:  
<http://www.carlisle.army.mil/USAWC/PARAMETERS/Articles/07summer/bahgat.htm>
- BBC (2010), *UN sanctions against Iran*, published 26 July 2010.  
(Reading date 13 October 2010)  
URL: <http://www.bbc.co.uk/news/world-middle-east-10768146>
- Beach, Sir Hugh (2009), *Trust & Verify*, Issue No. 125, Verification Research, Training and Information Centre (VERTIC), pp. 4-9
- Bodansky, David (2004), *Nuclear energy: principles, practices, and prospects*, 2. edition, Springer-Verlag, New York  
(Reading date 20 November 2010) URL:  
<http://books.google.com/books?id=qBqbr8uV9c8C&pg=PA32&dq=strauss+son+cheap+meter&hl=en#v=onepage&q=strauss%20son%20cheap%20meter&f=false>
- Brannan, Paul and Albright, David (2006), Institute for Science and International Security (ISIS), *ISIS Imagery Brief: New Activities at the Esfahan and Natanz Nuclear Sites in Iran*, ISIS published 14 April 2006.  
(Reading date 20 September 2010)  
URL: [http://www.spacelibrary.com/060414ISIS\\_IranNatanzNuclearSites.pdf](http://www.spacelibrary.com/060414ISIS_IranNatanzNuclearSites.pdf)
- Cassedy, E.S., and Grossman, P.Z. (1998), *Introduction to Energy- Resource, Technology, and Society*, Cambridge University Press, Cambridge
- Crall, Peter (2010), *Bushehr Fuel Loading Commences*, Arms Control Association (ACA), published September 2010. (Reading date 5 October 2010)  
URL: [http://www.armscontrol.org/act/2010\\_09/Bushehr](http://www.armscontrol.org/act/2010_09/Bushehr)

- Dehghan, Saeed Kamali and Black, Ian (2010), *Iran's defiant Green movement vows to fight on*, the Guardian, published 11 June 2010, (Reading date 21 November 2010) URL: <http://www.guardian.co.uk/world/2010/jun/11/iran-green-zahra-rahnnavard-mousavi>
- EC (2007), Commission of the European Communities, *The Sustainable Nuclear Energy Technology Platform: A Vision Report*, Luxembourg: Office for Official Publications of the European Communities (EUR 22842). (Reading date 16 November 2010)
- Forden, Geoffrey and Thomson, John (2007), *Iran as a Pioneer Case for Multilateral Nuclear Arrangements*, Science, Technology and Global Security Working Group, published by Massachusetts Institute of Technology
- Gundzik, Jephraim P. (2005), *The ties that bind China, Russia and Iran*, Asia Times, published 04 June 2005. (Reading date 29 July 2010) URL: <http://www.atimes.com/atimes/China/GF04Ad07.html>
- Hafezi, Parisa (2008), *Iran says atomic drive brings powers "to their knees"*, Reuters, published 20 February 2008. (Reading date 16 September 2010) URL: <http://www.Hafezi.com/article/worldNews/idUSL2061801920080220?feedType=RSS&feedName=worldNews&rpc=22&sp=true>
- IAEA (2010), GOV/2010/28 *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions 1737 (2006), 1747 (2007), 1803 (2008) and 1835 (2008) in the Islamic Republic of Iran*, IAEA published 31 May 2010. (Reading date 18 September 2010) URL: <http://www.iaea.org/Publications/Documents/Board/2010/gov2010-28.pdf>
- IAEA (2009), *Multinational Fuel Bank Proposal Reaches Key Milestone*, IAEA published 6 March 2009. (Reading date 3 June 2009) URL: <http://www.IAEA.org/NewsCenter/News/2009/fbankmilestone.html>
- IAEA (2007a), *Promoting Nuclear Security: What the IAEA is doing*. Fact sheet: 06-30961/FS Series 1/03 Rev.1/E, IAEA published 2007. (Reading date 29 July 2010) URL: <http://www.IAEA.org/Publications/Factsheets/English/nucsecurity.pdf>
- IAEA (2007b), GOV/2007/22, *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, IAEA published 23 May 2007. (Reading date 12 August 2010).

- URL: [http://isis-online.org/uploads/isis-reports/documents/IAEA\\_Iran\\_Report\\_23May2007.pdf](http://isis-online.org/uploads/isis-reports/documents/IAEA_Iran_Report_23May2007.pdf)
- IAEA (2005), GOV/2005/77, *Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran*, IAEA published 24 September 2005.  
(Reading date 28 September 2010). URL: <http://www.iaea.org/Publications/Documents/Board/2005/gov2005-77.pdf>
- IAEA (2004), GOV/2004/21, *Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran*, IAEA published 13 March 2004.  
(Reading date 25 September 2010). URL: <http://www.iaea.org/Publications/Documents/Board/2004/gov2004-21.pdf>
- IAEA (2003), GOV/2003/40, *Implementation of the NPT Safeguards agreement in the Islamic Republic of Iran*, IAEA published 6 June 2003.  
(Reading date: 27 September 2010) URL: <http://www.iaea.org/Publications/Documents/Board/2003/gov2003-40.pdf>
- IAEA (2001), *Nuclear Power for Sustainable Energy Development*, IAEA published 21 February 2001. (Reading date 29 July 2010)  
URL: <http://www.iaea.org/OurWork/ST/NE/Pess/csd9/background2.pdf>
- IAEA (1970), INFCIRC/140, *Treaty on the Non-Proliferation of Nuclear Weapons*, IAEA published 22 April 1970. (Reading date 19 September 2010) URL: <http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf>
- IISS, International Institute for Strategic Studies, (2004), *Iran's nuclear programme*, IISS Volume 10, Issue 9, published November 2004. (Reading date 22 November 2010) URL: <http://www.iiss.org/publications/strategic-comments/past-issues/volume-10-2004/volume-10---issue-9/irans-nuclear-programme/>
- Iranian Government (2010), INFCIRC/785, *Communication dated 1 March 2010* received from the Resident Representative of the Islamic Republic of Iran to the Agency regarding assurances of nuclear fuel supply, IAEA published 2 March 2010. (Reading date 18 September 2010) URL: <http://www.iaea.org/Publications/Documents/Infcircs/2010/infcirc785.pdf>
- Iranian Government (2005), INFCIRC/648, *Communication dated 1 august 2005* received from the Permanent Mission of the Islamic Republic of Iran to the Agency, IAEA published 1 August 2005. (Reading date 10 August 2010).

- URL:  
<http://www.iaea.org/Publications/Documents/Infcircs/2005/infcirc648.pdf>
- ISIS (2010a), Institute for Science and International Security, *Iran's Nuclear Program*, ISIS published. (Reading date 12 August 2010)  
 URL: <http://isis-online.org/country-pages/iran/>
- ISIS (2010b), *About ISIS*, ISIS published. (Reading date 29 November 2010)  
 URL: <http://isis-online.org/about/>
- Jasanoff, Sheila (2004), *Ordering Knowledge, Ordering Society*”, in *States of Knowledge: The Co-Production of Science and Social Order*, London Routledge, pp. 13-45 (chapter 2)
- Joerges, Bernward (1999), *Do Politics Have Artefacts?*, *Social Studies of Science Journal*, June 1999, Vol. 29, No. 3, pp. 411-431, Sage Publications, Ltd. (Reading date 16 September 2010)  
 URL: <http://sss.sagepub.com/content/29/3/411.short>
- King, Brandon (2006), Fact sheet: *The Nuclear Suppliers Group (NSG) at a Glance*, Arms Control Association (ACA). (Reading date 16 September 2010)  
 URL: <http://www.armscontrol.org/factsheets/NSG>
- Kippe, Halvor (2009), *Irans kjernefysiske program – for kraftproduksjon eller kjernevåpen?*, Forsvarets forskningsinstitutt (FFI), Kjeller
- Lidskog, Rolf and Sundqvist, Göran (2002), *The Role of Science in Environmental Regimes: The Case of LRTAP*, in *European Journal of International Relations*, SAGE Publications and ECPR, Vol. 8(1): pp. 77–101.
- Lodgaard, Sverre (2010), *Challenge from within: the case of Iran*. Routledge. Unpublished, but forthcoming. (Reading date: 29 June 2010)
- Mayer, Ann Elizabeth (1994), *Universal versus Islamic Human Rights: A Clash of Cultures or a Clash with a Construct*, *Michigan Journal of International Law*, Vol. 15, No. 2, Published winter 1994, pp. 307-404. (Reading date: 8 November 2010) URL:  
[http://heinonline.org/HOL/Page?handle=hein.journals/mjil15&div=15&g\\_sent=1&collection=journals](http://heinonline.org/HOL/Page?handle=hein.journals/mjil15&div=15&g_sent=1&collection=journals)
- Medvedev, Zhores A. (1990) *The Legacy of Chernobyl*, Basil Blackwell Ltd, Oxford

- Melman, Yossi and Javedanfar, Meir (2007), *The Nuclear Sphinx of Tehran: Mahmoud Ahmadinejad and the State of Iran*, Carroll and Graf Publishers, New York
- NEA, Nuclear Energy Agency (2008), *Competition in the front-end of the nuclear fuel cycle*, OECD Publications
- NEA (2007), ISBN: 978-92-64-00644-7, *Innovation in Nuclear Energy Technology*, OECD Publications
- NEA (2000), ISBN: 92-64-18278-0, *Nuclear Energy in a Sustainable Development Perspective*, OECD Publications. (Reading date 20 September 2010)  
URL: <http://www.nea.fr/ndd/docs/2000/nddsustdev.pdf>
- NTI, Nuclear Threat Initiative (2010a), *Iran Profile: Nuclear Overview*, James Martin Center for Non-proliferation Studies, Monterey Institute of International Studies, NTI. (Reading date 20 September 2010)  
URL: [http://www.nti.org/e\\_research/profiles/Iran/Nuclear/index.html](http://www.nti.org/e_research/profiles/Iran/Nuclear/index.html)
- NTI (2010b), *Iran Profile: Nuclear Chronology 1957-2010*, James Martin Center for Non-proliferation Studies, Monterey Institute of International Studies, NTI. (Reading date 20 September 2010)  
URL: [http://www.nti.org/e\\_research/profiles/Iran/Nuclear/chronology.html](http://www.nti.org/e_research/profiles/Iran/Nuclear/chronology.html)
- NTI (2010c), *About NTI*, NTI published. (Reading date 29 November 2010)  
URL: [http://www.nti.org/b\\_aboutnti/b\\_index.html](http://www.nti.org/b_aboutnti/b_index.html)
- Persbo, Andreas (2009), *Trust & Verify*, Issue No. 125, Verification Research, Training and Information Centre (VERTIC), pp. 1-3
- Perthes, Volker and Wegner, Eva (2006), Discussion Paper, *Enriching the Options: Europe, the United States and Iran*, German Institute for International and Security Affairs, published 12 June 2006. (Reading date: 29 June 2010)  
URL: [http://www.swp-berlin.org/common/get\\_document.php?asset\\_id=3019](http://www.swp-berlin.org/common/get_document.php?asset_id=3019)
- Rauf, Tariq and Simpson, Fiona (2004), *The Nuclear Fuel Cycle: Is It Time for a Multilateral Approach?*, Arms Control Association (ACA), published December 2004. (Reading date 15 August 2010)  
URL: [http://www.armscontrol.org/act/2004\\_12/Rauf](http://www.armscontrol.org/act/2004_12/Rauf)
- Security Council (2010), *France, Germany, United Kingdom of Great Britain and Northern Ireland and United States of America: draft resolution*, published: 4 June 2010. (Reading date 13 October 2010)  
URL: [http://www.foxnews.com/projects/pdf/060810\\_resolution.pdf](http://www.foxnews.com/projects/pdf/060810_resolution.pdf)

- Security Council (2006), *Elements of a revised proposal to Iran made by the E3+3*, published 15 September 2006. (Reading date 1 May 2010)  
URL: [http://www.armscontrol.org/pdf/20060606\\_Iran\\_P5+1\\_Proposal.pdf](http://www.armscontrol.org/pdf/20060606_Iran_P5+1_Proposal.pdf)
- Suleman, Arsalan M. (2008), *Bargaining in the Shadow of Violence: The NPT, IAEA, and Nuclear Non-Proliferation Negotiations*, Berkeley Journal of International Law, Berkeley.
- Winner, Langdon (1980), *Do artifacts have politics?*, in Daedalus. Journal of the American Academy of Arts and Sciences, pp. 121-136.
- Woolgar, Steve (1991), *The Turn to Technology in Social Studies of Science*, Science Technology & Human Values Journal, January 1991, Vol. 16, No. 1, pp. 20-50, Sage Publications, Ltd. (Reading date 16 November 2010)  
URL: <http://sth.sagepub.com/content/16/1/20.full.pdf+html>
- UN, United Nations (1987), General Assembly, A/RES/42/187, *Report of the World Commission on Environment and Development*, United Nations' Brundtland Commission, published 11 December 1987. (Reading date 20 September 2010) URL: <http://www.un.org/documents/ga/res/42/ares42-187.htm>
- Yaphe, Judith S. (2009), *Challenges to Persian Gulf Security: How Should the United States Respond?*, Institute for National Strategic Studies, National Defence University Press, no.237.